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# CHEMISTRY

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Editorial:
Space Chemistry
Inside Front Cover


50¢

Thirty-first Year

★ A SCIENCE SERVICE PUBLICATION ★

# Space Chemistry

➤ A NEW KIND OF CHEMIST is needed in man's conquest of space.

The automobile called forth specialized petroleum chemists. Plastics made necessary polymer chemists. All the many subdivisions of chemistry have grown from a need for persons who held a specialized knowledge of various situations.

The new breed of chemist will serve the space age. Whether space travel by humans commences a decade or a hundred years from now, civilization is about to enter an epoch when "space chemists" will be expected to answer questions asked by an increasing number of persons.

What is the chemistry of the space through which guided missiles and artificial satellites travel? What are the effects of unshielded cosmic rays on the metals and plastics used in building missiles, satellites, or even future space stations? Could atomic oxygen of the upper atmosphere be used to refuel rockets and other craft? These are some of the chemical questions relating to space.

**CHEMISTRY**

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▸ DEADLY NERVE GASES *can not harm this member of the Army Chemical Corps dressed in protective clothing while decontaminating G-agents in the Chemical Warfare Laboratories, Army Chemical Center, Md.*

# Chemical Super-Killers

*by* JOHN W. ROBINSON

▸ INDUSTRIAL CHEMISTS are helping the Army find more deadly chemical warfare agents by swapping trade secrets about poisonous compounds.

Many times industry discovers the compounds accidentally while doing research far removed from chemical warfare. In other industries, such as the insecticide industry, chemists may be working with compounds closely related to those used as weapons.

Scientists at the Army Chemical Center, Edgewood, Md., are extremely interested in all such compounds, and a small group of investigators travels the country to get leads on possible new warfare agents.

Industry benefits from the fact-swapping program, too, when toxic chemicals are sent to the Center for screening. The Center returns a complete report on the compound and its properties, security permitting.

### Saves Time and Money

The program has been going on since 1951 and prevents wasted time and money on research that has already been done before.

One of the most interesting aspects of chemical warfare agents is the testing program that is carried on by the Army.

Every month a new busload of American soldiers arrives at the Army Chemical Center for the top-secret research.

They are human volunteers who will spend 30 days at the Center, exposing themselves to hazards that few other Americans will ever have to face.

**Some Secrecy Lifted**

Up until now, what goes on inside the Center has been a jealously guarded secret. There are still many off limits areas, especially those concerned with nerve gas and other as yet unnamed weapons. But security is being relaxed enough to give the public a glimpse of the inner workings at the Center's 10,000-acre site just north of Baltimore.

The project most commonly associated with the Center is the work on nerve gas. The gas is not made at the Center in quantities but shipped there from a manufacturing plant in Colorado.

Civilian and Army scientists test it at the Center to determine the best ways to use it and the most effective means of protecting against it, explained Col. Lloyd E. Fellenz, Commanding Officer of the Chemical Warfare Laboratories at the Center.

On the battlefield, GB, as the most potent type of the gas is called, can turn a man into a convulsing and dying casualty within seconds. To the scientists at the Center, however, it holds little of the irrational terror which has been built up in the public mind.

The Center first began working with the gas when several German manufacturing plants for it were captured during World War II. Since then, slow and methodical research has been done to find out exactly how and why the gas works and what can prevent its lethal effect.

It was for this type of research that human volunteers soon became necessary.

**How Nerve Gases Work**

Once understood, nerve gas is not quite so terrifying. It kills by disrupting the communication lines between the brain and the muscles of the body. When the diaphragm muscles are hit and paralyzed the victim is unable to breathe and death follows quickly.

In the body it works this way: When a nerve impulse leaves the brain headed for a muscle, it must jump several gaps in the transmission line before it reaches its destination.

At these gaps, nature has put two delicately balanced chemicals which handle the cross-over. One is the hormone acetylcholine, formed when the impulse first hits the gap. The acetylcholine then floods across the gap and reestablishes the impulse on the other side.

But this hormone cannot be allowed to stay flooded across the gap since a continuous impulse would then be set up and the muscle would begin twitching and convulsing.

To prevent this, the body has available the enzyme cholinesterase in the gap. This enzyme inactivates the excess hormone and it is at this stage that nerve gas attacks the system.

Once inhaled, nerve gas compounds seek out the body's thousands of

nerve gaps. There, they lock up the cholinesterase molecules by forming a chemical bond with them and keeping them from inactivating the acetylcholine. The result is first convulsions in the body, as the muscles get nothing but stimulation, and then paralysis, as the gaps become completely inoperable.

The Center has not disclosed exactly how far human research has gone on the effects of GB, although they have admitted that volunteers are now being exposed to dilute concentrations of the gas.

So far there is only one drug useful for defense against the gas and that is atropine. This drug acts by limiting the body's sensitivity to excess acetylcholine, but it is only effective against relatively low concentrations of the gas. It must also be injected immediately upon exposure and is worthless as a preventive measure.

**Seek Immunity Pill**

"We're hoping to find something like a pill or capsule that a man could swallow to keep himself immune to the gas," Col. Fellenz said.

And much of the human volunteer work going on is aimed at the development of just such a pill.

The most promising compound to date is the complex chemical 2,3,-butanedione 2-oxime, or DAM for short.

The drug exhibits a protective effect in animals and is now being tested for safety in humans. But it is too early to say when a volunteer will be asked to expose himself to a killing dose of the gas to test the drug's value.

The volunteers used at the Center come from Army units all over the country. The men, and women (so far two WACs have been through the tests) are volunteers in the full sense of the word. They are not to be confused with the type of "volunteer" who has become the butt of many an Army joke.

They are not intimidated or coerced in any way; in fact, if anything, they have found it difficult to be released by their units and be accepted for the secret work.

Before arriving, the volunteers have learned only that the Center is developing and perfecting methods of defense against chemical warfare agents and that it has now become necessary to use human test subjects.

**May Leave Program**

They sign a legal document which guarantees that they may, at any time and for their own reasons, decline to participate in, or withdraw from a test. All of the testing is actually under their control since they can stop any phase of it whenever they wish.

Once inside the Center, the volunteers are given exhaustive physical and psychological tests to determine their fitness. When they leave they are put through the same tests to insure they have suffered no injury, mental or physical, from their experience. A psychiatrist also interviews the group to weed out any who are not emotionally stable enough to undergo the tests.

**Very Few Fail**

So far only two percent of a total of 471 volunteers has been rejected, Capt. Bernard Elfert, administrative officer for the Clinical Research Division, said.

Not all of the volunteers are used for nerve gas research. Some may

walk through tear-gas filled rooms to test new models of gas masks, others may be put in cold chambers at 40 degrees below zero Fahrenheit to test the value of protective clothing.

The most closely watched experiments, however, are those involving the use of deadly agents. Here the test subjects are given a thorough briefing by the doctors and scientists who supervise all the research. They are told exactly what is going to happen and how they will probably react to it.

There is never any attempt to fool or mislead them and the briefing is usually enough to allay any of their fears. But once in a while, a volunteer may decide that no matter how small the risk, it is still too great.

**Can Switch Projects**

In one case, a volunteer who had already entered the gassing unit decided not to go through with the experiment. The researchers were instantly aware of his reaction and the test was stopped. The volunteer wanted nothing more to do with the gassing experiments but he did elect to join other phases of research at the Center.

So far, the safety record of the Center has been excellent. There have been no harmful accidents and none of the volunteers are purposely subjected to a test that will harm them.

## *New Type of Chemical Bond*

➤ A NEW TYPE of chemical bond, opening up wide horizons of research and throwing new light on catalysts, the substances which speed up chemical reactions, has been discovered.

Dr. Walter Edgell of Purdue University found that in cobalt carbonyl hydride ($Co(CO)_4H$) the hydrogen atom is bonded to three of the four carbonyl (CO) groups and to the cobalt atom as well. Previously it was believed that the hydrogen was attached either to one of the CO groups or solely to the cobalt atom. Spectroscopic studies yielded results that were inconsistent with either view, however.

Dr. Edgell's "bridge model" is supported by spectroscopic studies. In addition it is substantiated by measurements of the way in which the hydrogen nucleus lines up its axis of precession within the magnetic field of the molecule's electron cloud (nuclear magnetic resonance).

Metal carbonyl hydrides such as the compound studied in this project are used as catalysts in making gasoline and in manufacturing alcohol. Dr. Edgell's findings help explain how this chemical legerdemain is accomplished. They also contribute to a consistent theory of chemical bonding.

The research was performed under a grant from the Atomic Energy Commission.

Synthetic gems are superior to real gems for industrial use because they are perfect.

Fantastically high speeds and temperatures of the space age may reach up to 25 times the speed of sound and around 1,000 degrees Fahrenheit.

**True Romance of Chemistry Lies in Common Elements**

# Polymers, Crystals and Plasmas

*by* Dr. Guy Suits
*Vice President and Director of Research, General Electric Company*

(From a speech presented at the Science and Industry Symposium, Oklahoma City, Okla., June 17, 1957)

## Introduction

▶ Recently I became engaged in a conversation about my favorite subject — research in science — with a young friend who was particularly impressed with some new information he had just picked up at school concerning the existence of "more than a hundred" chemical elements.

"If I were going to become a scientist," he asked, "which elements would be the best ones to study? I don't suppose I'd have time for all of them."

Since my young friend is only ten years old, he will have a good deal of time to further his research, but as an immediate answer to his question I mentioned five elements and suggested that these five might be especially interesting to study.

After a brief session with his junior encyclopedia, my friend returned, and his disappointment was apparent. My stock as a scientific advisor had obviously dropped several points.

"I looked up a list of all the elements, and gee, some of them were just discovered last year and the year before. But it says all of the ones *you* told me about were 'known to the ancients'."

In an effort to salvage my reputation, I explained that it was true that the elements I had mentioned had been discovered long ago. "But," I said, "they are also very common, very cheap, and very plentiful and because of that they are the ones to which we can add the most value by research. Almost anything we can do to them makes them more valuable."

By way of emphasis, I told him that there was a billion dollars worth of silicon right in his backyard, and that some of our scientists had actually made diamonds out of peanut butter, and by then his eyes were fairly popping. Just plain old iron, all by itself, I assured him, has turned out to be the strongest metal of all, and even the strongest metals may not be as useful for tomorrow's world as some materials made out of new combinations of those wonderfully common elements: oxygen, hydrogen, and carbon. And one member of this simple trio, hydrogen, may contain the ultimate answer to our need for safe and inexpensive energy.

## Old Elements Spark Progress

We are at a place in the cycle of scientific progress where it is highly profitable to apply our newest knowledge to the study of the oldest elements — some so old that they were "known to the ancients."

Here I intend to focus on three

areas of science where exciting progress is being made, areas where the key elements are the simple ones I have mentioned. Sometimes they appear in combination and sometimes very much alone. These are not the only areas of great scientific progress by any means, and I would not belittle the importance of studying elements with fancier names than oxygen, carbon, and hydrogen — that's an important and exciting frontier too. But these fields which I will discuss are particularly interesting and important to industry — and especially to the electrical industry, and they appear so complex that there is every chance that there will still be opportunities in them even when my ten-year-old friend is weighing the approximately 500 job offers he can expect after finishing his graduate studies in science in 1970.

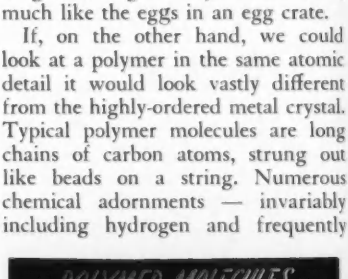
**Part I: Polymers**

➤ First, let us consider polymers, because they touch upon human experience so many times each day, and have so much to do with our future. I trust the term "polymer" does not bother you as much as it did a business associate of mine who is better known for his managerial skill than for his technical prowess. Recently, he called me to say, "Why didn't you tell me that this conference on polymers you had at the laboratory last week was all about plastics — I would have come."

Perhaps the toothbrush is the first place, each day, where we contact a polymer, although of course we may have slept on one the night before. The toothbrush handle, and probably the bristles too, are made from polymers, as are all plastics. There was a time, about two or maybe three decades ago, when critical users thought that polymers were not much good for anything but toothbrush handles. To be sure, these early polymers had some deficiencies, particularly in strength. Most anything you could make from them would fall apart in your hands, or under foot, and if you wanted to make something really strong you had to use a metal or an alloy. This difference in strength between polymers, as synthetic chemical solids, and metals, as refined natural solids, includes a basic difference in structure.

If you take any metallic material, polish it and etch the surface, you can readily see the characteristic crystalline structure, generally made up of many small crystals packed together in random array. Consider one crystal in this aggregate; its atoms are arranged in regular layers and rows, much like the eggs in an egg crate.

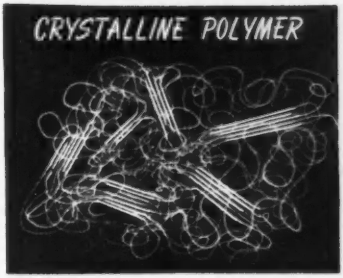
If, on the other hand, we could look at a polymer in the same atomic detail it would look vastly different from the highly-ordered metal crystal. Typical polymer molecules are long chains of carbon atoms, strung out like beads on a string. Numerous chemical adornments — invariably including hydrogen and frequently



our old friend oxygen — are attached to this string of beads to form side chains that impart much of the chemical and physical character to the polymer. An aggregate of such polymer molecules, if we could see it under a super microscope, might look something like the arrangement of fibres in a sheet of cotton batting — a tangle of long chain molecules, running in every direction. This classical structural characteristic of polymers is principally accountable for the poor strength of these materials. The molecules themselves are strong. But the aggregate is not, since the individual molecules run in random directions with very little coordination between them. We may tie the molecules together, with chemical cross-links, and improve the strength. Another and more successful way would be to make them more crystalline, by lining up the long molecules, or portions of them. Then they would gain strength from their structural regularity, somewhat analogous to the manner in which a woven fabric gains strength in comparison to our cotton batting.

With this word of introduction, the new look in polymers is very simply explained; they are becoming more crystalline — that is, more highly ordered — and hence stronger. The newest and strongest polymers are a remarkable improvement over the older ones.

The new progress — partly in Ziegler process polyethylene, partly in Montecatini polypropylene, partly in numerous developments in this country in new silicones and polycarbonates — is in aggregate a very significant step forward. There is no doubt that polymers have come a long way from the old toothbrush handles.




These new high-strength polymers have led the chemists to make some exciting extrapolations into the future, where they see progressively higher strength and better high-temperature performance. This certainly should result in much wider use for polymers in years to come.

No doubt polymers will replace metals in many applications. In fact, they are doing it now. Most of them aren't yet as strong as most metals in common use, but many metals in use are stronger than they need to be to do the job at hand.

To tell the truth, in our research laboratory, we have a friendly fight on right now between the chemists and metallurgists. The chemists say that in another ten or fifteen years or so our company will be using more polymers than metals in our products. Need I add that the building blocks of these new polymer materials, carbon, oxygen, hydrogen and silicon, are the ones my young friend said were originally discovered a long time ago?

PART II: CRYSTALS will appear in the November issue of CHEMISTRY.

**Never Too Young to Start Science Career**

# Young Girl Co-Authors ACS Paper

➤ A YOUNG SCIENCE FAIR enthusiast virtually stole the show from world-famous scientists during the 132nd national meeting of the American Chemical Society in New York.

She co-authored a paper reporting that cooking time can be greatly reduced by adding harmless glycerine to the water in which foods are cooked.

A chemist, a research chemical engineer and the 14-year-old girl, who plans a career in science, reported the addition of glycerine to cooking water can cut food cooking time by as much as 50% without changing cooking techniques, altering nutritive value or digestability of foods.

James Kanegis, chief of the chemical section of the U. S. Department of Commerce Office of Technical Services, Washington, his daughter Brenda, and Dr. Roger Gilmont, Manostat Corporation, New York, investigated the addition of glycerine in several methods of cooking, including hard boiling, scrambling and poaching of eggs, double boiling of cereal, pressure cooking of potatoes in steam and boiling of prunes in water.

### Cut Time in Half

In almost all cases, the investigators found cooking time could be cut in half by the addition of about 60% glycerine by weight to the water.

The new technique grew out of a desire of Brenda Kanegis to reduce the time she devoted to cooking for her father and 11-year-old brother, Gary. After consulting scientists associated with glycerine manufacture and uses, she enlisted her father's help in devising experiments to measure glycerine's effects on cooking.

### Science Fair Project

From her studies the Hyattsville (Md.) Junior High School student devised a detailed science fair project which won second place in the chemistry section of the Prince Georges County (Md.) Science Fair.

Mr. Kanegis said Dr. Gilmont, a family friend, saw the science fair project report "and told us he believed it to be significant original work that should be published." He studied the chemical thermodynamics of the new technique and the three of them co-authored the paper delivered in New York Sept. 9 by Dr. Gilmont in the presence of Brenda and her father.

Brenda plans a career in science, "possibly as a technical stenographer," inspired by her father's book on technical stenography.

Mr. Kanegis told CHEMISTRY the glycerine and water technique could replace fats and oils in the frying of many foods, as demonstrated in the experiments with scrambled eggs.

"Fats and oils are used in frying," he pointed out, "to enable the cook to achieve a higher temperature than can be obtained with water. The addition of glycerine to water accom-

plishes this purpose without filling the kitchen air with grease and smoke. Glycerine vaporizes only very slightly from the water."

Glycerine is an inexpensive, moderately sweet, syrupy liquid technically regarded as an alcohol, but having few of the characteristics commonly associated with alcohols. It is a by-product of soap manufacture and is used in printers ink, medicinal preparations, and is called for in some recipes as a partial replacement for sugar as a sweetening agent.

In double boiling of cereals and hard boiling of eggs, there is no occasion for the food to come in contact with glycerine, Mr. Kanegis said. In pressure cooking, he said the experiments showed that only the water vaporized to penetrate foods, and that the glycerine remained a liquid, and did not sweeten the food. In direct immersion boiling, such as with dried prunes, glycerine added "a pleasant, sweet flavor," Mr. Kanegis said.

## √ *Chemistry Quiz* √

*Directions*: Mark within the parentheses corresponding to the answer you think is *most nearly correct*. Answers are on page 11.

1. Which of the following elements is chemically least like the other three?
   ( ) 1. argon
   ( ) 2. chlorine
   ( ) 3. krypton
   ( ) 4. neon

2. In a general sense, a process of transferring energy from a body across space is called
   ( ) 1. elasticity
   ( ) 2. magnetism
   ( ) 3. polarization
   ( ) 4. radiation

3. Which of the following terms has least in common with the other three?
   ( ) 1. fluorescence
   ( ) 2. incandescence
   ( ) 3. luminescence
   ( ) 4. phosphorescence

4. Which of the following refers to the theory and application of electromechanical phenomena in crystals?
   ( ) 1. crystallography
   ( ) 2. electrocapillarity
   ( ) 3. kinematics
   ( ) 4. piezoelectricity

5. A meson is
   ( ) 1. a dormant spore
   ( ) 2. a stage in the development of a yeast cell
   ( ) 3. a sub-atomic particle
   ( ) 4. an acid-base indicator

These questions have been taken from Science Aptitude Examinations used in previous years as part of the annual Science Talent Search. Complete copies (with answers and norms) of many previous examinations are available at 10c each from Science Service, 1719 N St., N.W., Washington 6, D.C.

## For The Home Lab

# Furfural From Bran

*by* Burton L. Hawk

➤ Just about 25 short years ago, furfural was a costly curiosity. The compound, obtained from the action of acid on bran, oat hulls, corn cobs, etc., was known but no one had developed any use for it. So it was just not produced.

Today the situation has changed. Furfural is inexpensive and is available in carload quantities. Its use? Perhaps it would be easier to list the items it is not used in. It is a very good solvent and is used as such for cellulose esters and in the refining of petroleum oils. It is important in the manufacture of plastics, such as "Durite" and similar types. It is used in the preparation of varnishes, in vulcanization, and for other important organic compounds. Besides these many-sided roles, it is an insecticide, fungicide, gemicide and barbicide.

What is it? It is simply an aldehyde and its full name is furfuraldehyde, or for short, furaldehyde, or for shorter, furfural. It is quite similar to benzaldehyde, which it resembles in many chemical characteristics. Its odor even reminds one of benzaldehyde.

Furfural is prepared by treating a pentose or a pentosan with dilute sulfuric acid. We will use bran as our natural source as this is probably the most available for the home chemist. You can use Kellogg's "All-Bran" cereal, which can be obtained at the local grocery store. Then you can eat what is left over.

Place 25 grams of the bran in a 500 ml. Erlenmeyer flask. Add 150 cc. of water and 15 cc. of concentrated sulfuric acid. This mixture is then distilled. To do this, insert a one-hole stopper in the flask. Carefully push the end of a glass tubing through the stopper the other end of which extends to another vessel which is immersed in ice water. Apply heat to the flask and allow the mixture to boil gently. If the mixture should foam excessively, remove the flame until it calms down again. Continue the distillation until you obtain about 100 cc. of distillate. The distillate should be nearly colorless.

Neutralization is next in order. Drop a piece of litmus paper into the distillate. Add sodium hydroxide solution, with stirring, until the litmus paper *just* turns blue. Then add a drop of dilute sulfuric acid.

When the mixture has been neutralized, add 40 grams of common salt and again distill the mixture using the same arrangement as described above. This time collect about 30 cc. of the distillate. This is crude furfural.

You can test for the presence of furfural with aniline acetate test paper. Prepare this by adding a few drops of aniline to 1 cc. of dilute acetic acid. Soak a piece of filter paper in this solution and drop the wet paper into a few cc. of the furfural solution. The paper will be colored bright red. For another variety of this test, dissolve a few drops of

aniline in one cc. of alcohol. Add this to a small volume of the furfural solution and follow with dilute acetic acid. A beautiful red solution is obtained.

The furfural you have prepared is not pure. You can purify the solution you have by extraction with ether. We do not like to recommend this process for the home chemist unless it is absolutely necessary because of the danger of explosion and fire. Working with ether is quite hazardous, and should not be attempted by the inexperienced. If you feel that you are qualified you may proceed as follows:

Again saturate your impure solution of furfural with common salt. Add ether, shake well, and filter quickly. The ether is removed by distillation and the furfural remains. Do not heat the mixture with a direct flame. Set the dish in a warm place or immerse in hot water until the odor of ether can no longer be detected. Make sure that all burners and open flames are extinguished in the room where you are working with ether. After the ether has evaporated, distill the remaining portion. Collect that part of the liquid which distils over at 160-165 deg. This is relatively pure furfural.

As stated previously, furfural is similar to benzaldehyde. You may recall a past experiment in this series that reacted benzaldehyde with concentrated potassium hydroxide to form benzyl alcohol and potassium benzoate. Thus the same reaction with furfural yields furfuryl alcohol and potassium furoate. Benzaldehyde, in a condensation reaction with alcoholic cyanide produces benzoin. Furfural, in the same manner, forms furoin.

Furfural can also be obtained from other sources. Place a small amount of gum arabic in a test tube. Add dilute sulfuric acid and heat to boiling. Test the vapors with aniline acetate test paper, as outlined above. You may try this preparation with oat hulls or with pieces of corn cob if you wish.

And finally, let us glimpse at the history of furfural. Oats are raised primarily for the kernel which is used for cereal. The hulls were discarded as a useless waste. Then, slowly the hulls became useful as cattle feed. But they were quite difficult to digest. Chemists attempted to increase their digestibility by treating the hulls with acid, but instead they obtained furfural. A new compound from a waste material . . . but with no uses. It was worth then (1922) $6.50 per lb. The chief object was to find a use for the compound. This, as we know, has been done. Now, strangely enough, the raising of oats is more important for the hulls than for the kernel! Such is the demand for furfural! And, who likes oatmeal anyway?

*A discussion of levulinic acid, related to furfural begins on page* 13.

√ Answers to CHEMISTRY QUIZ on page 9. √

1, 2; 2, 4; 3, 2; 4, 4; 5, 3

**Make This School Year**
**A Science Year**

# October National Science Youth Month

➤ THIS IS THE second year October has been designated as National Science Youth Month.

A national, even world-wide, movement to give encouragement to students who have chosen careers in the sciences and to assist teachers as they promote the science interests of their students is not new. The major precept upon which Science Service was founded in 1921 — the popularization of science — has grown through the years into an active, effective, three-pronged National Science Youth Program: Science Clubs of America, National Science Fair, Science Talent Search for the Westinghouse Science Scholarships.

Our new and present need for more scientists and scientists of highest quality has caused many organizations to adopt some of the proven science - career - encouragement techniques of the National Science Youth Program's Clubs, Fairs and Talent Search. Other organizations, including some leading industrial concerns and the National Science Foundation have, through various means, joined directly with Science Service toward accomplishing the Program's goals.

In 1956 it was decided to bring together all the efforts for which Science Service, at least, was responsible early in the school year in order that teachers and students, parents and civic leaders, radio, newspaper and TV organizations and scientists themselves could see at one glance what was being done to explain scientific careers, and how they could augment these efforts.

➤ EIGHTH *National Science Fair, Los Angeles, May 9-11, 1957.*

October was designated as the month, and October, 1956, as National Science Youth Month was hailed a success in all its aspects.

Experience gained by Science Service in the first year's operation was turned over to the President's Committee for the Development of Scientists and Engineers for expansion and further work which has resulted in an even bigger, more wide-spread "October." Over a dozen organizations have been active in planning the 1957 National Science Youth Month and already other organizations have requested active roles for 1958. Many more dozens of organizations are cooperating in various ways.

Educators, science club sponsors and science fair cooperators have received packets of information designed to help them carry out their plans for October.

**Levulinic Acid is Used Everywhere — But Almost Unknown**

# The Cinderella Chemical

*by* R. Winston Liggett, *Head, Industrial Chemistry Section, Southern Research Institute*

*From the Bulletin of Southern Research Institute*

Every once in a while a new chemical comes along that for some reason excites the imagination of industrial chemists. It may be because it is a by-product associated with a product of such major importance that a tremendous supply is available. It may be that it is easily made from some abundant and otherwise worthless raw material. It may be because it is associated with a popular field of research, such as petrochemicals or chemurgy. Such a new chemical is levulinic acid.

During the past twenty years levulinic acid has aroused major interest in at least five major companies in five major industries. Yet levulinic acid remains a paradox, a Cinderella chemical still waiting for the ball. It has all the features of an interesting industrial chemical: unusual chemical structure, readily available raw materials, and potentially low enough cost for large volume use. It is a chemical with enormous possibilities, remaining on the verge of potential development, but thus far eluding extensive industrial application.

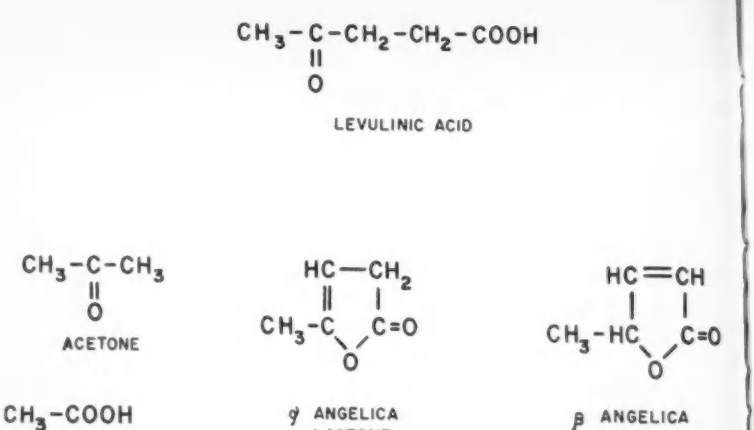
The possibility of producing levulinic acid at low cost is comparatively new, and it presages widening potential uses for this chemical. Levulinic acid is made from carbohydrates, such as sugars, starches, and wood. When made from sugars and starches, its cost has been relatively high. Since 1951, a relatively simple chemical process has been available for making it from cellulosic plant materials which are annually replenished by nature. At present its cheapest source of supply is probably waste wood products, for example, sawdust.

None of the companies which has focused interest on levulinic acid in the past has been a basic chemical producer. This may be another clue to its slow development. The average chemist, when asked about its uses, will scratch his head, reach for a pencil, and then perhaps ask to have his memory refreshed on the chemical structure of levulinic acid. Its name gives him no clue as to its nature.

### Structure

What is levulinic acid? The organic chemist calls it gamma-ketovaleric acid or 4-ketopentanoic acid. For the chemical merchandising man, it can be described as related to acetone, lactic acid, and furfural. One end of it looks and acts somewhat like acetone. The other end is a strong organic acid like lactic or acetic acid. It is produced from carbohydrates by a process somewhat similar to that used for making furfural from oat hulls and corn cobs.

However, it must be admitted that




➤ LEVULINIC ACID *and some of its relatives.*

today it cannot displace any of these related materials in most of their large volume uses because it is more expensive. When the cost factor is considered, levulinic acid becomes the poor relative.

**Uses**

Circumstances are changing, however. Whereas, even ten years ago, comparatively expensive sugars or starches were being considered as the raw materials, now it is known that almost worthless wood cellulose can be used for making levulinic acid. This does not mean that levulinic acid can be made for nothing, for other chemical raw materials are also needed. But it does mean that an ample supply is going to be available, with the cost dropping as manufacturing know-how and sales volume increase.

Many of the best potential uses for levulinic acid have been discovered

during the past ten years.* These new uses represent the kind of results that are to be expected when patient industrial utilization research techniques are applied. For example:

One of the advantages of levulinic acid is its extremely low toxicity. Consequently, it has been used in the past as a food acid in the manufacture of carbonated beverages. Also, in the field of medicine, calcium levulinate is known to be the best form of calcium for intravenous injection. Recently it has been found that low toxicity and other special properties of levulinic salts make possible important uses in cosmetics.

Quite often, utilization research deals with highly publicized consumer products. One such product is the synthetic detergent. Modern washing machines are dependent on modern detergents. One of the components of these detergents is the "anti-soil redeposition" agent. Certain cellulose derivatives, when added to the detergent mixture, prevent the dirt that is removed by the detergent from settling back again on the cloth from which it came. It has been found that cellulose acetate levulinates are particularly effective in preventing this soil redeposition on fabrics.

In many cases, new uses for chemical products are found by more careful study of a general field which has been known for some time. Esters, in general, have many possible uses in making resins or plastics, and many esters of levulinic acid have been suggested for such uses. Since it is known that levulinate esters cannot compete price-wise in the general classification of plastic or resin solvents (such as acetone) or as general duty plasticizers such as tricresyl phosphate or dioctyl phthalate, specialty uses have to be sought.

Such special uses are gradually being discovered. Substitution of levulinyl groups for a portion of the acetyl groups in both polyvinyl acetate and cellulose acetate yields materials of increased strength. It has also been found that small percentages of plasticizers derived from levulinic acid greatly improve many vinyl plastics.

The most interesting chemicals that are readily prepared from levulinic acid are the angelica lactones, an important group of compounds that find use as solvents and as intermediates for fine chemicals manufacture. Here is found a confusing nomenclature. Angelica lactone certainly sounds more euphonious than levulinic acid, but it is a misleading name. Alpha-angelica lactone (actually the gamma lactone of 4-hydroxy-3-pentenoic acid) is readily formed by vapor phase dehydration of levulinic acid. Beta-angelica lactone (the gamma lactone of 4-hydroxy-2-pentenoic acid) is formed in small amounts at the same time, or can be prepared from alpha-angelica lactone. Generally speaking, alpha-angelica lactone is the least stable. Reduction of either lactone or levulinic acid produces gamma-valerolactone. Under the proper conditions, in the presence of ammonia or suitable amine, the corresponding lactams or pyrrolidones are easily made. All of these materials are excellent solvents, some of them with unusual properties. For instance, they can be used as solvents in the spinning of synthetic

* Some of these discoveries have been made at Southern Research Institute under a long-term research program sponsored by Newport Industries, Inc. (now a division of Heyden-Newport Chemical Corporation).

fibers such as acrilan.

Levulinic acid and the three lactones are all completely soluble in aromatic solvents, such as benzene and toluene. All three lactones are soluble in turpentine, but levulinic acid is not. Alpha-angelica lactone is almost insoluble in water, but the other two lactones and levulinic acid itself are completely soluble in all proportions. In mineral spirits levulinic acid and beta-angelica lactone are insoluble, and the other two lactones are completely miscible.

These strange and unpredictable solubility relationships frequently are found in other levulinic acid derivatives. Although they complicate the systematic study of levulinic acid chemistry, at the same time they provide the basis for new uses for the acid. Such properties are strange only until we become used to them. The only really strange and unusual fact is that levulinic acid is the only simple acid of its type that is available for general industrial use. It is certain that more uses are going to be discovered and that more levulinic acid is going to be available for these uses.

*Home lab experiments with furfural, related to levulinic acid, are described on page* 10.

## *Vaccine Against Worst Cattle Disease*

➤ A TEAM of American scientists has perfected a vaccine against the world's worst cattle disease, rinderpest. The new vaccine, described as the most effective ever produced, is already being used successfully in Africa and Asia where rinderpest kills millions of head of cattle annually.

Although the viral disease is unknown in this country, scientists and cattlemen fear that it may slip past our border inspectors some day. If this should happen, they point out, it would be a major disaster. Rinderpest is the world's deadliest cattle disease, killing 90% to 100% of the cattle it infects. American cattle, scientists say, are highly susceptible to the disease.

Rinderpest is not carried by an insect, but is passed on by direct contact or indirectly in straw or bedding.

The new vaccine, developed by a team of Government scientists, was produced as a stockpile weapon in the nation's biological arsenal against the day rinderpest might reach the United States. Earlier work was done on a vaccine during World War II when it was suspected that the Germans were planning to use rinderpest as a biological warfare weapon against this nation.

The rinderpest vaccine, recently granted a patent by the U.S. Government, is made of rinderpest virus material which has been rendered non-infective by chemical means, cell material derived from *Mycobacterium butyricum*, a water-non-miscible substance and an emulsifier.

It is the invention of Drs. Fred D. Maurer of the Armed Forces Institute of Pathology; Donald E. De Tray and Kenneth L. Kuttler of the U.S. Department of Agriculture and Alfred M. Webb of the Department of the Army Chemical Corps.

**Students, Teachers Urged to Attend**

# American Chemical Society Meetings

➤ LAST MONTH many of the 12,000 persons who flooded into 11 major New York City hotels for the 132nd meeting of the American Chemical Society gave more than passing attention to the co-author of a paper presented in the Division of Agricultural and Food Chemistry. The nature of the paper itself was worth much of the attention. It was concerned with a new technique of using glycerine to speed cooking.

Food developments affect all persons, and the paper was easily understood even by non-chemists. Of course many of the 1500 papers presented at the meeting were easy to understand and will have effects close to home. However, only one was researched and co-authored by a 14-year-old girl.

The story of Branda Kanegis, Hyattsville (Md.) Junior High School science fair enthusiast, appears on page eight. Here it will suffice to say she was only one of dozens of students of all ages and interests who were welcomed by the chemists, who profited from attendance at meetings and symposia, who were given the benefits of meeting famous scientists and chemical educators, of talking with chemical company top officials and laboratory technicians.

### Opportunities To Meet Chemists

For most of the students it was not the first opportunity to discuss their chosen careers with top scientists. Many had already been given this opportunity at local and regional science fairs, and undoubtedly some were present who had enjoyed lively discussion with some of the world's most famous scientists at the annual National Science Fairs. Science Talent Search finalists have the same opportunity during their visit to Washington for the Science Talent Institute.

No matter how many opportunities are available to discuss careers, or even some finer technical points, students are always hungry for more. The editors of CHEMISTRY frequently meet students, and teachers, who long to attend ACS meetings, but who believe the meetings are open only to members of the Society, or that meetings are never held close enough to their homes to permit their attendance.

### Students May Attend

There are categories of registration for all types of persons at American Chemical Society meetings. College students who are regularly enrolled in work leading to a degree in chemistry and who are student affiliates of the Society may register at a reduced rate. High school students are always welcome at non-member rates and those high school teachers who are not ACS members and do not classify themselves as chemists may register at the non-member rate of $7.00.

Meetings are held throughout the United States. During the last two years of high school, by which time the outstanding student should have read and discussed the field widely

enough to benefit from the meetings, almost certainly a meeting will be held within a reasonable travelling distance from the student's home.

The major meetings are held twice each year, in the Spring and the Fall, and run for a week.

### Meetings Distributed Geographically

The Spring, 1957, meeting was held in Miami and the Fall meeting in New York. Meetings scheduled are: April 13-18, 1958, San Francisco; Sept. 7-12, 1958, Chicago; April 5-10, 1959, Boston.

So far the ACS has not scheduled national meeting events particularly for high school teachers and students, but there is always enough of interest taking place during the week, or even on any one day if time is limited, to make registration worthwhile. Registration must be completed before entrance can be gained to meetings.

### Students and Teachers Benefit

The Division of Chemical Education always carries a heavy schedule of papers and discussions of new techniques of teaching and curriculum planning. Some of the papers are devoted to particular technical points of chemistry as they can be better presented to students. Of course the Division is primarily interested in college level education, but most high school teachers attending will be preparing their students for college work and will benefit from the discussions. Students who listen carefully in meetings, and who manage to become part of intelligent corridor discussions, will gain a valuable insight into what they will face and what will be expected of them in college chemistry courses.

Naturally, the technical meetings—many of which the truly interested high school student with wide reading experience should be able to follow profitably — are open to all who have registered. The comprehensive program booklet will guide students and teachers to the most beneficial meetings.

In connection with national meetings many companies and ACS publishing offices display their books and other publications and staff the exhibits with informed persons available for discussion.

Finally, a word to students in buttonholing chemists for discussions.

### How to Talk to a Chemist

Although chemists as a group are deeply interested in helping young students with their careers and work hard at encouraging students to choose chemistry, they have strong professional and business reasons for being at the meetings and their time is limited.

Do not take too much of a chemist's time. Know in advance just why you want to talk with a particular chemist, and have a mental rough idea of the questions you want to ask. Do not try to talk about something too far beyond your academic and experience preparation — the chemist will have to take his time to teach you a course in chemistry before he can even discuss your question. Do not ask questions to which you already know the answer — it will be obvious and merely indicate bad manners. Above all, do not try to show the chemist how much you know. Your presence at the meeting indicates to him that you have enough interest in chemistry to have acquired an above-average knowledge for your age.

**The President of the American Chemical Society Speaks**

# Chemists Have Good Reason To Be Proud of Their Work

➤ ALTHOUGH American Chemical Society meetings traditionally open on Sunday with registration, the 132nd national meeting of the ACS actually got underway in earnest with the Monday evening address of president Roger J. Williams, director of the University of Texas Biochemical Institute.

Dr. Williams gave his address the title "Fiddlers' Dreams," explaining that he referred to scientific, rather than musical, fiddlers. Such fiddlers, he said, are "spontaneous explorers," who break away from traditional paths, do experiments which fly in the face of accepted techniques, and attempt the unheard of. Their fiddling, he noted, usually precedes the more artistic performances of the scientific violinists — "masters of technique, producers of beautiful scientific music in the form of elegant products employed in the useful arts, developers of equally elegant mathematical equations and tools of scientific value."

### Defends Fiddlers

One reason for discussing the subject, Dr. Williams continued, was his desire to "defend fiddlers and fiddling in general against those who may turn up their noses at anything that falls short of the ultimate in sophisticated 'highbrow' investigation—investigation that can be described only in technical words which would be utterly incomprehensible to laymen." He stressed the belief that "there is plenty of room, even yet, for what we may call the 'garden variety' of research."

Describing biochemistry as a fertile field for fiddlers' research, he turned to a discussion of his own laboratories' recent studies on variations in body chemistry, and the biochemical basis of alcoholism.

### Spot Alcoholics Early

Tests have been developed that can be given children to spot just which ones are likely to grow up to be alcoholics. Then, by feeding them the right foods, they can be kept from that fate.

Appetites and abnormal cravings, like the craving for alcohol, have their seat in the hypothalamus of the brain, evidence indicates, and it seems likely that in alcoholics this portion of the brain has a deranged metabolism.

In alcoholics, Dr. Williams explained, the appetite-regulating center of the brain becomes malnourished.

That is because in potential alcoholics the nutritional needs of the brain center are unusual. Relatively high amounts of certain nutrients are needed, and it is not the same nutrients that are crucial in each case.

When anyone drinks alcohol in quantity, this tends to crowd out of the diet the wholesome foods which contain minerals, amino acids and

vitamins. But when the potential alcoholic does this, it induces a circular effect which causes him to drink more and more alcohol.

That is because when he neglects to eat the specific foods demanded by his individual appetite center, the appetite center becomes deranged and he develops his abnormal craving.

"We have demonstrated beyond question dozens of times that in experimental animals the desire to drink alcohol is in a striking way a function of their nutrition.

"Well nourished animals drink little or none; poorly nourished animals always drink alcohol at a high level. Animals deliberately made deficient in a certain food element will drink heavily but will cease the drinking immediately when the missing food element is supplied."

"It is my judgment," he declared, "based on experience and realistic appraisal, that most alcoholics who will cooperate can be greatly benefited now, and that the craving can be abolished more and more effectively in all, as the result of further research."

**Chemists' Pride Justified**

"Chemists can be proud of their work for many reasons. I believe they will have reason to be increasingly proud because it is through chemistry that we gain irrefutable evidence of the individuality of each of us. Knowledge of this individuality is not only indispensable for the treatment of human illnesses, but is crucial also for social advance. Chemistry is capable of contributing in a signal manner to the social sciences. It can help usher in a tremendous improvement in human relations — at a point where our civilization is weakest and where advance is desperately needed."

**Improve Human Relations**

Besides their obvious bearing upon the treatment of disease, the Texas researchers' findings "have broader implications for the field of human relations," Dr. Williams asserted. One reason that knowledge of human relations has lagged seriously while natural science has advanced rapidly in the nineteenth and twentieth centuries, he said, is that "we have not realized the degree to which each of us is different from his fellows." Consequently, he said, we have oversimplified the whole problem by thinking of human relations as involving "man," a hypothetical average creature, instead of "men," each of whom is to a high degree a different individual.

Commenting that "nuclear weapons could never be the cause of our downfall if our human relations were satisfactory," Dr. Williams appealed for wider recognition of individual differences as a necessary prelude to a sound plan for social advance.

"If an emphasis on human differences should mean a disregard for the ways in which we are alike, this would be bad," he conceded, "but such is not the case, and it seems clear to me that the best way to engender a brotherly feeling among members of the human family is to know ourselves as we are — highly distinctive individuals — and not the products of an assembly line."

# Propose Study of Almost Every Plant

▶ THE NATION'S scientists have been called upon to help solve the farm surplus problem by launching a thorough scientific study of every plant in the world.

Out of at least 250,000 different kinds of plants around the globe, a mere 52 are listed as "principal" crops, and only 100 other species are grown commercially in the United States. Thus, the farmer may have overlooked important opportunities, asserted Wheeler McMillen, vice president of *Farm Journal,* Inc., at the 132nd national meeting of the American Chemical Society.

Farm surpluses "could conceivably be prevented," declared Mr. McMillen, if farmers were able to produce "an adequate diversity of crops acceptable to industry as raw materials." He suggested that some 40,000,000 acres of standard crops "in the right areas" be replaced with new crops with industrial potential. To develop such new farm crops, he proposed that an extensive botanical study be organized, with the aid of scientists in many other countries. He continued:

"The processes of nature can synthesize a good many important industrial compounds more cheaply than can be accomplished by chemistry. Some of these materials are needed by industry in quantities and qualities greater and better than are currently available. Considering the vastness of man's ignorance regarding the vegetable kingdom it is strongly probable that industrially valuable compounds are being manufactured in the process of plant growth which not only remain undiscovered but for which the need remains yet undisclosed.

"The imperative need is for profitable new crops which farmers can plant on those acres which are no longer needed for unmarketable wheat, unsalable cotton, and excess corn.

"What are the prospects that industry might afford markets for such crops? Industry in the United States does not now have adequate sources of cellulose for pulp, paper and plastic products.

"Dependable and sufficient sources for hard and soft fibres are lacking.

"Suitable raw materials for all the desired pharmaceuticals are not easily obtainable.

"Industry could use raw materials for anti-oxidants, for gums and for waxes.

"Supplies of domestic vegetable tanning agents are very short.

"More oils of vegetable origin, possessing the most desirable specific characteristics, are still to be sought.

"Proteins of plant origin offer industrial potentials yet to be realized.

"Enough evidence is on hand to indicate that a comprehensive inspection of the entire vegetable kingdom could bring new materials to industry and new crops to agriculture.

"In speaking of a new crop we do not necessarily think of a plant hitherto unknown to agriculture but simply of one not firmly established in

regular economic production.

"The most urgent reasons for seeking new crops arise because agriculture needs diversity. As a broad objective it is our belief that the entire flora of the earth should as rapidly as possible be subjected to whatever scientific techniques will disclose essential knowledge. This clearly would be no small-scale undertaking. The chemical composition of some plants varies at different stages of growth. Different parts of a plant contain different constituents.

"A thoroughly comprehensive study therefore would involve examinations of roots, stalks, leaves, bark, flowers and fruit at varying stages of growth for at least a quarter of a million species of plants.

"In actual practice the undertaking might not be quite so formidable. Beginnings naturally would be made with those families and genera where the prospecting appears most promising.

"It should be emphasized, however, that because industrial potentials are so diverse, and because future needs are unpredictable, no species of plant should be overlooked."

A substitute for cotton is one urgent agricultural need, the speaker indicated, and several likely prospects are not known. The roots of canaigre yield a material which has been well tested for leather tanning and this crop could replace as many as 100,000 acres of cotton, he said. Following are some of the other potential farm crops which he listed as able to grow well in the United States.

*Bamboo,* a particularly attractive new prospect for use as pulp for paper as well as for structural materials, furniture and specialties. In terms of cellulose per acre, bamboo is considered to be four times as productive as southern pine. It will grow in the Southern coastal and Piedmont areas where peanuts and cotton are problem crops. Possibly a million acres could be occupied profitably by bamboo.

*Sansevieria,* a candidate for a source of hard fibre, once problems of cultivation, extraction and development are worked out. This fibre, which has points of superiority over sisal, could be grown on some 100,000 acres in southern Florida.

*Kenaf,* a possible substitute for jute, will grow wherever cotton does.

*Jojoba,* or Simmondsia, a wild plant from the southwest, which is the most promising new vegetable source of wax. A potential of 150,000 acres is estimated.

Among other potentials he included Guar, as a source of an ingredient valuable to the paper industry, strains of sesame as an edible oil and the roots of a native American sunflower (Heliopsys) which contains an insecticidal material.

**Antibiotic-Treated Food Harmless**

➤ AMERICANS ARE in no danger, so far, from eating foods that were originally treated with antibiotics before harvest, a Government scientist told the American Chemical Society.

Increased use of antibiotics to treat the diseases of crops and animals and stimulate growth of swine and poultry has caused "apprehension in the minds of some of the consuming public," Dr. Donald C. Grove of the U. S. Food and Drug Administration explained.

But in the applications being used to date, Dr. Grove said, the antibiotics

have been found to be "completely dissipated before they could get into final food."

To date, three antibiotics — streptomycin, a combination of streptomycin and oxytetracycline, and actidione — are being used to control plant diseases. Streptomycin, chlortetracycline, oxytetracycline and bacitracin are being used in animals.

Whereas none of these antibiotics has been found in the blood or tissues of animals fed the chemicals to stimulate growth, the FDA has been concerned about the use of penicillin to treat mastitis in cows.

"While it has not been proved that small residues of penicillin in milk have caused reactions or may be harmful, it is believed that it could be a potential danger and might cause a reaction in a person extremely sensitive or allergic to penicillin," Dr. Grove said.

Dr. Grove said that the FDA is keeping a "watchful eye" on the use of antibiotics in all situations, including using them for preserving foods, to protect the public health.

**Nuclear Radiation Safe**

▶ CORN PROTEIN and wheat gluten sterilized by gamma rays from a nuclear reactor do not lose their nutritive value as foods, it was reported to the American Chemical Society.

University of Illinois scientists are carefully watching several generations of laboratory animals for signs of any possible genetic effects from irradiated diets. Drs. V. Chalam Metta and B. Connor Johnson reported irradiation did not produce off-flavors or odors and that the sterilized foods, in balanced diets, were completely acceptable to laboratory animals.

Although no induced radiation has been found, irradiation sometimes causes changes in the chemical structure of foods. It is the effect of these changed structures the University of Illinois scientists are investigating.

Dr. Metta said it is too early to make broad conclusions about the safety of radiation-sterilized foods, but experience with four generations of rats "has been encouraging and we feel there is room to hope the treated foods will prove safe." He anticipates another two years of study before a final report can be made.

A commonly-used corn protein food comparable to that under-going test is corn meal, Dr. Metta said.

## *Tough New Plastic Can Replace Metals*

▶ A TOUGH NEW plastic that can withstand the blows of a carpenter's hammer has been discovered and developed. The plastic is expected to replace metals and ceramics in some applications.

Called Lexan by its developer, the General Electric Company, the plastic is a polycarbonate resin. Now being made in small lots, the polymer is being evaluated in the form of molding compound, film, varnish and coatings. It can be made in a variety of opaque and transparent colors and has excellent electrical characteristics, high thermal stability, low water absorption and high tensile strength.

Polycarbonate chemistry, which resulted in the development of Lexan, is a new technology that promises newer and better plastics.

**Divisions of Biological And Medicinal Chemistry**

# Understanding of Action Basic to Life Reported

➤ THE MYSTERY surrounding one of the most elementary chemical reactions basic to life has been unraveled. The solution may lead to a better understanding of cancer, a Yale University biochemist told the American Chemical Society.

The mechanism by which food energy is converted to energy forms that can be used by living tissue was reported by Dr. Gifford B. Pinchot. His explanation also clarifies the function of ribose nucleic acid, or RNA, in cells. Until now scientists have been at a loss to explain RNA's function in cells.

Scientists long have known that body energy is obtained from the step-by-step breakdown and oxidation of food. The way in which the breakdown takes place is well understood, Dr. Pinchot said. However, the scientists have faced a blank wall in trying to understand how the resulting energy is transformed into a type of energy that can support life, a process called oxidative phosphorylation.

The enzyme system responsible for the energy transformation earlier had been broken down into its components at Yale. Among the components, Dr. Pinchot found a fraction that did not appear to be an enzyme. A year of study proved it to be "a polynucleotide of the ribose nucleic acid type," a complex chemical compound occurring in cell nuclei. Variation of RNA behavior is believed to be related to the occurrence of cancer.

"It has frequently been suggested that the primary difference between cancer and normal cells may consist in a disturbed energy metabolism in the malignant cells," Dr. Pinchot said, "and it is obvious that a thorough knowledge of the normal process is required before one can evaluate changes in the disease."

In seeking knowledge of the normal process, Dr. Pinchot has found that the RNA acts by binding the enzymes of the oxidative phosphorylation to each other. Thus, Dr. Pinchot said, the RNA functions as a coenzyme which binds energy-producing enzymes to the cell.

### Credit Vitamin K

A Harvard University Medical School scientist, Dr. A. F. Brodie, described vitamin K, a fat-soluble vitamin necessary for growth, as a coenzyme "vital in respiration and conversion of food substances into energy."

Both scientists used bacteria as the life forms necessary to their studies of energy transfer. Dr. Brodie believes "an immediate application" of his work could be the development of compounds capable of destroying bacteria by blocking the energy transfer process.

### Hunch Proves Valuable

How a "chemical hunch" paid off with the development of two new agents, said to be highly active against cancer in mice and rats, was reported

by chemists from the University of Wisconsin and from Hoffman - La Roche, Inc., Nutley, N. J.

Dr. Charles Heidelberger of the University of Wisconsin told the Society's Division of Biological Chemistry that, on the basis of differences in the production of nucleic acids in tumors and in normal tissues, researchers were able to predict successfully a new class of compounds which would be highly selective in killing cancerous cells without appreciably affecting normal tissue.

Dr. Heidelberger reasoned that such agents — known as anti-metabolites — would be accepted by the cancer cells and would upset their metabolic processes, while normal cells, less dependent on these substances, would be relatively unharmed. Antimetabolites are materials which are similar in chemical makeup to compounds essential for synthesis of new human tissue, but which differ just enough to prevent or interfere with cell growth.

By using antimetabolites, chemists hope to trick the fast growing cancer cell into accepting the foreign material which it cannot utilize for its growth, so that it will slowly starve to death for want of needed building material. Sulfa drugs and antibiotics are thought to work in the same way.

The two new compounds, technically known as 5-fluorouracil riboside and 5-fluorouracil deoxyriboside, were developed by Dr. R. Duschinsky and co-workers at Hoffman - La Roche. They differ from naturally occurring compounds called pyrimidines — the building blocks for nucleic acids in the body — only in the substitution of a fluorine atom in place of a hydrogen atom.

Earlier research by other workers showed that uracil (a pyrimidine) was taken into nucleic acid of tumor tissues at a higher rate than into normal tissues, Dr. Duschinsky noted.

"This observation suggested the investigation of uracil antimetabolites as potential cancer chemotherapeutic agents," he continued.

"Fluorouracil, in which a hydrogen of uracil has been replaced by a fluorine atom, was shown to inhibit growth of microorganisms in the test tube and growth of transplanted tumors in mice and rats by interfering with nucleic acid metabolism. It is taken into ribonucleic acid (RNA) and prevents the synthesis of deoxyribonucleic acid (DNA), a substance found in the nucleus of cells."

The success of fluorouracil led to the idea that even more powerful anti-cancer activity would be shown if the fluorine-substituted compound was related to DNA more closely than uracil.

This hunch was confirmed by tests both at Hoffman-La Roche and in the McArdle Memorial Laboratory of the University of Wisconsin. Both new compounds were tested in various mouse tumors, and the 5-fluorouracil deoxyriboside, particularly, was found to be well tolerated and superior to 5-fluorouracil, said Dr. Duschinsky.

### Misleading Reports Cited

Many reports on cancer cures, based on tests with transplanted tumors, are misleading and in danger of raising false hopes, a top cancer researcher warned.

Results with transplants "are not directly applicable" to spontaneous

cancer and, unfortunately, the majority of reports on "cures" of the transplanted cancers are not verified on natural tumors before they are announced, said Dr. Jacob Furth, associate director of research at Children's Cancer Research Foundation, Harvard Medical School. Success in controlling transplanted tumors cannot necessarily be regarded as indicating the way to control a tumor which develops spontaneously in the body, he explained. This is because each individual has a powerful natural defense system in the antibodies—the tiny substances in the bloodstream that combat any foreign substances such as transplanted cancer cells which invade the body.

"This mechanism is strongly operative against experimental grafted tumors and has been for decades the source of false cures," declared Dr. Furth, who is doctor of medicine and 1957 president of the American Association for Cancer Research. "When chemical or other agents destroy part of the tumor, the antibodies are mobilized and they finish the job of complete destruction of the tumor. Unfortunately, natural tumor cells of man and animals are, in general, so close to normal cells as to fail to provide the formation of antibodies.

"It is conceivable that some tumor cells contain hidden antigenic substances which, by special tricks, could be liberated and would form antibodies which, in turn, would restrain natural tumors, but the public is to be warned that, contrary to claims recurrent for decades, this is a distant research aim."

Studies using cancer transplants are valuable in revealing new information about tumors and in aiding the scientist in his search for cures, Dr. Furth pointed out. But, he emphasized, "vital findings require confirmation with natural tumors."

Knowledge of such factors as hormones and vitamin requirements within the body of the host — person who has cancer — is the basis of "many known procedures which are now successfully used in cancer control," the speaker observed.

So diverse have been the findings of cancer researchers that clinicians face a problem in the selection of agents for testing, said another speaker at the symposium, which was held by the Society's Division of Medicinal Chemistry. More refined techniques are needed for studying the effects of a given drug on a tumor, according to Dr. D. A. Karnofsky, Sloan-Kettering Institute for Cancer Research, who continued:

"The clinician has no general measurable disturbance, common to all forms of cancer, which permits him to follow the response to therapy.

"Some progress is being made. Even in the 'hopeless' cases, we are able today to make life more comfortable, and in some instances we are able to delay the progress of the disease."

A complex substance present in all living cells — deoxyribonucleic acid, (DNA) — was linked with cancer by Dr. Saul Kit of the M. D. Anderson Hospital and Tumor Institute, University of Texas. He said "it would appear logical" that alterations of the DNA composition are "responsible for activity of tumor cells, which are geared for survival and progres-

sive growth, even in unfavorable environments."

DNA determines the structural characteristics of the cell, he explained, and therefore it affects the cell's use of nutrients. In addition, it dictates hereditary traits. The way in which DNA functions is not yet clearly understood, Dr. Kit conceded.

The possibility of developing a vaccine against cancer — if it is established that viruses are responsible for cancer — was indicated by Dr. Charlotte Friend of the Sloan-Kettering Institute.

Dr. Friend, a chemist, expressed the view that a test might be developed which could indicate the presence of a cancer-causing virus even before the disease itself becomes evident. She said some researchers believe that the infective agent comes from a substance within the host which somehow goes astray, whereas others contend that it is an infection from an outside source.

**Atherosclerosis Research Reported**

New evidence that atherosclerosis — a type of hardening of the arteries — may result from eating too much of one kind of fat and not enough of another kind was presented by Dr. Douglas V. Frost of Abbott Laboratories, North Chicago, Ill.

Dr. Frost said he and his colleagues had produced atherosclerosis in rabbits by feeding the animals a diet in which the only fat was hydrogenated coconut oil.

No degeneration or thickening of the artery walls occurred, however, in rabbits whose dietary fat consisted entirely of safflower oil, he said, adding that human beings appear to react to fats in the diet in the same manner as rabbits.

Hydrogenated or saturated fats, which are solids at ordinary temperatures, are produced through the chemical addition of hydrogen to liquid oils. This is the commercial method for making shortening, margarine and soap fats. Such natural products as lard and butter also contain a relatively large amount of saturated fats. Dr. Frost stated that the coconut oil used in his tests was "virtually saturated throughout," whereas the safflower oil contained little saturated fat. About 70 per cent of safflower oil is linoleic acid, an essential fatty acid that is relatively unsaturated.

In order to determine the effect of individual nutrients, such as dietary fat, the chemists selected a diet for the rabbits in which all nutrients were compounds of known chemical composition. "Although initial difficulties were encountered in getting rabbits to accept this ration, the idea proved successful, the speaker commented.

Rabbits fed high levels of at least one hydrogenated fat synthesize enough cholesterol of their own to develop atherosclerosis," Dr. Frost continued. Cholesterol is a fatty substance found in the deposits in and on the inner linings of the arteries in atherosclerosis.

"Studies have indicated that in contrast to chickens and rats, who handle added dietary cholesterol without too much difficulty, rabbits have relatively low tolerance for added cholesterol and are easily subject to experimental atherosclerosis," observed the chemist.

"From all appearance, the human being may be just as susceptible as the rabbit to the good or ill effects of various types of dietary fat. Apparently only in the human being has a lowering of blood cholesterol been effected by adding fats high in essential fatty acids to the 'normal' diet," he observed.

**Cholesterol Content Listed**

Heart patients who want to keep track of the cholesterol in their diet may now find it as easy as counting calories with a newly prepared list of the cholesterol content of many everyday foods.

This was presented by Dr. Isaiah S. Botwinick, Midtown Clinical Laboratory, New York.

It will help in the easy substitution of low-cholesterol-content foods in the diet with a minimum of effort and expense, Dr. Botwinick said. The list will also aid the food and canning industry and enable them to answer the questions of physicians and dietitians about the cholesterol in processed foods, he added.

An average daily menu for "Joe Smith, American," shows that a healthy 150-pound male eats 600 milligrams (mg), or one-fiftieth of an ounce, of cholesterol in one day. This amounts to about 15% of the total cholesterol in the blood.

Here is the cholesterol content given for some common foods: one egg, 64.5 mg; two slices of enriched white bread, 15 mg; boiled ham, 2 lean slices, 103 mg; one teaspoonful mayonnaise, 17.3 mg; one ounce rye and four ounces ginger ale, none; four ounces lean sirloin steak, 94.8 mg; green peas, none, and cherry pie, 80 mg.

Until very recently patients who had abnormally high blood serum cholesterol levels were considered incurable, Dr. Botwinick said.

But during the past year some of these patients have been on a low cholesterol diet with cholesterol reducing substances and have had their blood serum cholesterol brought down to the normal levels, he added.

**High Blood Pressure Reduced**

New chemical compounds having strong activity against high blood pressure were reported.

The drugs, which have not yet been given trade names, are known as ganglionic-blocking agents, and because of their greater activity, may replace some hypotensive agents now available to physicians, Drs. Rex Pinson, D. E. Hutcheon and S. Y. P'an, Charles Pfizer & Company, Inc., Brooklyn, said.

The new drugs are regarded as "chemical surgeons" because they accomplish an effect previously accomplished by surgery. Ganglionic-blocking agents block the passage of nerve impulses through the junction points on the way to artery walls. These impulses, if allowed to proceed, would constrict the artery walls and cause higher blood pressure. For some years high blood pressure has been treated surgically, in some cases by cutting the nerves which cause the artery walls to contract.

Some of the new compounds, technically known as bisquaternary benzylalkalene-diamine derivatives, are said to be twice as potent as the most powerful blocking agents now available.

Dr. Pinson said that the most promising of the new compounds is now undergoing clinical trial.

**Sugars Protect Body Chemicals**

Sugars have been found to protect delicate enzymes from the harmful effects of X-rays, three Syracuse University biochemists reported.

Drs. Trevor Robinson, A. W. Phillips and Shirley Dilg, Biological and Food Research Laboratories and department of bacteriology and botany, Syracuse University, also suggested two possible ways in which the sugars protect enzymes.

In laboratory tests, the scientists irradiated several enzymes with X-rays until the enzymes were only half as active as normal. The same X-ray dose was then administered to enzymes mixed with sugars.

The biochemists found that sugars had a protective effect in amounts as low as or even lower than those required for previously discovered sulfhydryl protective compounds.

Enzymes, intricate compounds produced in living cells, are vital to life processes because of their ability to break down complex substances into simpler materials that can be used by a living body. Most enzymes are extremely sensitive to changes in their surroundings, and to various types of radiation which render them inactive. Important body functions stop when the activity of responsible enzymes is lowered, as in the case of X-ray overdoses reaching some enzymes.

Many enzymes are dependent for their activity on the presence of organic sulfhydryl groups, compounds containing sulfur-hydrogen radicals. Such compounds have been used to protect enzymes from X-irradiation in the past. The Syracuse researchers found that even some enzymes, such as catalase and aldolase, which do not depend on the presence of sulfhydryl groups for their activity, are also protected from X-ray effects by sugars.

Two possible explanations of the protective action were presented: 1. X-rays cause portions of the medium surrounding the enzyme to detach as free radicals, which in turn attach themselves to the enzymes with harmful effects. It is possible that sugars compete with enzymes for the free radicals, grabbing them before they can become attached to the enzymes. 2. The sugars are transformed into complexes that have an actual shielding effect.

**Stop Dental Cavities**

A group of compounds that show promise of preventing dental cavities by inhibiting chemical reactions in the mouth leading to tooth decay was reported.

Chemicals that combat a bacteria and enzyme reaction on sugar deposits in the mouth were prepared synthetically and studied for dental use by Drs. Saul B. Needleman, Leonard S. Fosdick and R. Quentin Blackwell, chemistry department, Northwestern University Dental School, Chicago.

A generally accepted theory of tooth cavity formation, the scientists said, is that bacteria lodged on teeth contain enzymes capable of breaking down some sugar residues into weak acids, lactic acid and pyruvic acid, which attack teeth. The process is called glycolysis, and the Northwestern researchers proceeded on a theory that any compounds that could prevent any step in glycolysis could inhibit formation of dental caries.

Thirty-six organic chemicals were prepared. The scientists found that those containing a free carbon atom at the end of a carboxyl arrangement in their structures were highly effective in preventing glycolysis. The protein amino acids lysine and leucine proved most effective.

**Tests Evaluate TB**

Physicians can now keep track of the progress tuberculosis patients make against the disease by three simple chemical tests that can be performed routinely by hospital laboratory technicians.

The new tests are expected to make possible more effective treatment of tuberculosis.

The tests, developed at Pollak Hospital for Chest Diseases, Jersey City, N. J., measure the rise and fall of defense mechanisms and antibodies produced by the patient.

Using them, physicians can determine the direction and degree of a patient's progress over intervals as short as a month, Drs. Milton Gross, Samuel Cohen and Gerhardt Klawitter reported.

In the past, measurement of the proteins that can best indicate the direction being taken by TB has involved methods too cumbersome for routine use, the scientists said.

Various globulins, or blood proteins, contain the antibodies patients need for recovery. A modification of tests used in cancer and liver disease research accurately measures the rise and fall of the globulins.

The tests were performed every month on 131 patients, most of whom had active TB, Dr. Gross said. High values for globulin factors measured were found in patients with severe disease. If the patient was responsive to treatment, Dr. Gross said, the values gradually came down to normal levels. If the disease was stationary, there was little change in the globulin values and, in cases of extensive and progressive tuberculosis, values became higher.

**Test For Orinase Found**

The discovery of how Orinase can replace insulin in some diabetic cases may be brought closer by a new chemical test.

The test eliminates the need for radioactive tracers in determining the presence of Orinase, the tolbutamide compound that has gained fame as a pill-form substitute for insulin injections in certain relatively mild diabetes cases.

Dr. Hugh J. McDonald and Vincent J. Sawinski, department of biochemistry, Stritch School of Medicine of Loyola University, Chicago, reported the new test uses common reagents in two simple steps. The presence of tolbutamide is indicated by green and orange colors, the intensities of which show the amount of tolbutamide present in body fluids being examined.

In order to learn how tolbutamide reacts in a diabetic patient, biochemists need to know where it locates in the body. Previous work has been based on radioactively tagging the compound, then following its course with "complicated and relatively costly nuclear instruments," Dr. McDonald said.

He believes the simple chemical test will prove its value by enabling more investigators to carry out research on insulin substances.

# Nature Has No "Classified" Secrets

▶ Scientists, having learned how to free the energy of the atom, are coming to believe that "there are no 'classified' secrets of nature — they are all open to him who can uncover them."

Dr. Norris W. Rakestraw made this statement at the American Chemical Society meeting in an address accepting a $1,000 prize for his contributions to chemical education.

"We are now daring to ask questions and think of possibilities which we dared not think of and ask a few years ago," Dr. Rakestraw said. "What questions will we be asking of nature a hundred years from now — or a thousand — or five thousand? Without a doubt, some of the questions which now we can imagine no way of even attacking will then be matters of common knowledge rather than conjecture."

Dr. Rakestraw, head of the chemistry division of the Scripps Institute of Oceanography, La Jolla, Calif., was for many years editor of the Journal of Chemical Education, published by the ACS Division of Chemical Education. He was presented the Scientific Apparatus Makers Award in Chemical Education.

Dr. Rakestraw's topic was "Chemical Education — Then and Now," and he stressed the enormous progress made, during his lifetime, in technology and in man's understanding of the world's phenomena.

"How differently the structure of matter appears now than it did when you and I first studied chemistry!" he reminded his audience. "How much more confident we can be that other mysteries, which we now only glimpse, will someday be laid bare."

It is not long, he pointed out, since thunder and lightning, storms and drought, the movements of the sun, moon and stars, the visitations of sickness and disease "were all mysteries enshrouded with religious superstition, not to be questioned but only regarded with wonder and awe."

Now "we really know something about them, and can even control some of them," Dr. Rakestraw said, continuing:

"This conquest has taken place within a relatively short time, as the age of our world is reckoned. The very beginning of science and our real knowledge of the world was only a few thousand years ago, while man's inhabitation of the earth is probably a hundred times longer. But the gradient of the learning curve has really become significant only within the last few hundred years. Does anyone imagine that this curve will flatten? The acceleration is much more likely to continue. And to what limit — if any?

"We are already seriously asking how the earth came into being, even the whole universe itself. Of course, people have always been interested in

this, but we are beyond the stage of vaguely imagining or apologetically suggesting.

"We feel we have more than merely hypothetical ideas of how the chemical elements came into being and evolved one from the other. Scientific discussions of the origin of life are lifting the subject out of the realm of symbolism and may soon be as commonplace as the annual Gordon Conferences.

"In the realm of practical projects, interplanetary travel is a seriously contemplated objective, and people now living are hoping to set foot on the moon."

Dr. Rakestraw expressed the conviction that "man's world will always be a challenge to his intellect, and he will never rest as long as there is an unanswered question in his mind."

Such are some of the challenges facing science education, of which chemical education is a part, he explained, "for after all, science education cannot be separated from the advance of science itself."

Citing the widespread concern in recent years over a reported shortage of scientific and technical manpower, Dr. Rakestraw stressed the relationship of this shortage to "an evident ineffectiveness of science education in the schools, particularly the secondary schools." He said the high school teacher was perhaps the most important factor in determining our future supply of trained scientific talent, but he cautioned his hearers against trying to improve chemical education instead of science education in general.

"We must forget any vested interest of chemistry in the high school and help to promote all science, as well as mathematics," he declared. "If the position of science is strengthened in the secondary school, chemistry will come in for its fair share, and this does not necessarily mean abolishing chemistry as a curricular subject.

"We are in competition with forces which would turn young people away from science and technology for mistaken reasons. Counselors are themselves poorly informed or even wrongly motivated. We must make it clear that science is *not* leading the world to ruin; that it is *not* too difficult for a young man or woman to hope to understand; that it is *not* a poorly paid profession; that scientists are *not* all egg-heads and 'squares.' There is plenty which can be put on the positive side of the ledger, and we must see that this is clearly shown and understood.

"Even in the larger sense, we must impress young people with the fact that knowledge in any field, scientific or otherwise, is worth striving for. There is too great a temptation for young people — at least in this country — to believe that the world is getting along prosperously enough and that there are no good reasons for any particular exertion.

"We know very well, on the other hand, that our great need is not merely for *more* scientists and engineers, but for more exceptional, top-notch men in these fields — indeed in all fields of endeavor. Superior intelligence, superior accomplishment, must be sought and striven for."

### Chemistry Defined

Dr. Allen B. Simon, Brooklyn College, proposed a definition of chem-

istry designed to recognize the entire field, but emphasize the fundamental nature of the science.

His definition is based on electronic considerations:

"Chemistry is that science which deals with the causes and effects of the donation, acceptance, or sharing of (orbital) electrons between atomic or molecular species, and with the energy-position relationships of the electrons within the species."

This definition, Dr. Simon said, is correct for all the studies of chemistry. In borderline areas, such as the transmutation of the elements, it points out the line of demarcation between chemistry and the contiguous science, he said.

Dr. Simon claimed several advantages for the definition over descriptions or enumerations now given: it pin-points the seat of the fundamental operations of chemistry; it is in line with the present textbook trend toward a basic, theoretical approach; it leads naturally to a discussion of the build-up of the periodic table, of bond structure, of the distinctions between reaction types, of metallic nature, of modern concepts of acids and bases.

### Toy Beads Are Models

A little girl's "poppit" beads are helping scientists to determine the chemical structures of such complicated substances as antibiotics, hormones and cellulose, her chemist father reported.

Simple molecular models, readily made from the beads in a variety of colors, are valuable tools in research and also useful visual aids for teaching biochemistry, according to Dr. R. Quentin Blackwell, associate professor of chemistry in the Northwestern University Dental School.

The beads, with appropriate color identification, have also been used to construct models of sugar, insulin, enzymes and nucleic acids and to help illustrate chemical processes in digestion and muscular action, it was reported. The determinations of some of the molecular structures in this field of life chemistry have been termed the most important scientific goals of our time.

The molecules of these natural materials are chain-like arrangements made up of units that are complex in themselves, and detailed models are so involved one can't see the forest for the trees, the professor said. Each plastic poppit bead can be used to represent one of the units in demonstrating their relationship to each other and the nature of the molecular structure as a whole.

"I should mention that this is such an obvious idea I am confident others have found the beads to be handy teaching aids," Dr. Blackwell commented, adding:

"My attention was drawn to them originally by my daughter Mary, so I must acknowledge my indebtedness to her for scattering them around the house in the first place.

"As visual aids in the biochemistry course I teach in the evening divisions at Northwestern University, the models have been well received, and on occasion have been used by my colleagues. For research applications, they have been employed to search for favored amino acid sequences in the chain-like chemical structures."

**Division of Chemical Literature**

# Russian Inventors Can Choose Patents or Certificates

➤ THE LOT OF THE Soviet inventor was described to the closing sessions of the American Chemical Society's meeting by Mordecai Hoseh, editor of *Chemical Abstracts*.

The Russian inventor, Mr. Hoseh said, can seek protection under either a patent or a certificate of authorship. If he wins a patent, he has sole rights to his invention and can license it on his own terms, providing it is not of "special importance to the state."

Under the author's certificate, on the other hand, the inventor transfers his rights to the Government and receives a honorarium fixed by the Government.

"Soviet citizens are discouraged from requesting patents, and inducements are offered to choose authors' certificates instead," Mr. Hoseh noted.

The inventor with a patent collects licensing fees, but must pay a fee in turn for the patent, and pay taxes on the fees he collects from licensees.

The inventor with an author's certificate enjoys different privileges, Mr. Hoseh pointed out.

"If the invention needs perfecting or further experimentation, time and facilities are offered free to the inventor to complete his invention. Payments received for an invention or suggestion for technical improvement are not taxable, or only at a reduced rate. Inventors have a priority in promotion," he explained.

"Generally, the Soviet Government through its ministries and their subdivisions greatly encourages 'inventiveness' through all sorts of prizes, praises and promotions."

Mr. Hoseh added some other facts about the Soviet patent system. Neither a patent nor a certificate, for example, can be obtained for a chemical compound; only for a new method of preparing it. Only certificates are issued for medicinals, foods and condiments, but both patents and certificates are granted for new ways of preparing such substances. Certificates solely are granted for new methods of treating diseases.

Soviet patent literature, Mr. Hoseh reported, is about the hardest of all Soviet literature to obtain.

## Next Month in Chemistry

*Articles in CHEMISTRY for November will include Lithium in the home lab, a discussion of fertilizer chemicals, National Science Fair projects, Crystals and other articles and regular features. See inside back cover for subscription information.*

# Japanese Owe Chemists Thanks

TEN MILLION Japanese were expected to starve to death after World War II, but Japan's chemical industry was rebuilt so rapidly that production now exceeds pre-war levels and, "in fact, no one starved to death."

This statement was among the highlights of a special report presented to the Society by Dr. Yuzaburo Nagai, president of the Chemical Society of Japan.

Because of the great need for food, Japan's reconstruction was begun with the chemical fertilizer industry, said Dr. Nagai, who is professor emeritus in the University of Tokyo and professor in Tokyo's Metropolitan University. So successful was this effort that by 1949 production of ammonium sulfate fertilizer exceeded the highest pre-war level.

A new synthetic fiber from polyurea, invented by researchers of the Tokyo Koatsu Company, was among the chemical advances described by Dr. Nagai. Quality of this fiber "is considered quite good" and "it seems suitable" for fishing nets and other articles, he said. Continuing development in the chemical field is helping to raise the nation's living standard, and the people are beginning to enjoy their peaceful life, according to the speaker.

Dr. Nagai credited economic assistance from the United States for much of this progress.

"The chemical fertilizer industry is still the most essential part of the chemical industry in Japan, but its importance is gradually declining," Dr. Nagai said. "On the other hand, synthetic resins are steadily and considerably increasing their position within the industry.

"One big portion of Japan's chemical industry is the manufacturing of chemical textiles. Through this industry, Japan obtained $201,000,000 foreign exchange in 1955 and $254,000,000 in 1956. . . . There are still many fields to be exploited in the demand for synthetic fibers. The demand is still unknown and the situation is very favorable."

Demand for nylon for fishing nets and clothing, still exceeds supply, said Dr. Nagai and market price exceeds the price set by the manufacturer. Even new mass production techniques do not influence the market price.

Other materials for which production trends in Japan look favorable are glass and cement, he reported. The future of Japan's chemical industry is considered quite bright, according to Dr. Nagai, but there are limitations in resources to be overcome.

"The total area of Japan is somewhat smaller than California and, out of this, arable land does not exceed 20 per cent," he stated. "Ninety million people are living on this land. Although we do have a present yearly production of approximately 47,000,000 tons of coal, the final extent of

production allowable on a commercial basis is considered to be 65,000,000 tons. The production of domestic crude oil cannot be expected to go higher than 60,000,000 barrels a year, which is equivalent to only 3 per cent of Japan's present consumption. Also, hydraulic power is no longer plentiful.

"We will come to import more fuels and raw materials for industrial use in the future and will seek markets for more exports of products," he said.

**New Outdoor Polyethylene**

A weather-resistant polyethylene for use outdoors will soon be offered to plastic molders and vacuum formers.

The new polyethylene compound has been made possible as a result of "recent developments in the field of ultraviolet inhibitors," according to L. W. A. Meyer and Ben P. Rouse Jr. of the Tenite Division, Tennessee Eastman Company, Kingsport, Tenn.

In comparison with conventional polyethylene resin, the new compound shows no signs of surface deterioration after being exposed four times as long to accelerated weathering tests, the report said.

Mr. Meyer also said that use of the recently developed, higher density polyethylene resins in conjunction with new techniques of forming and molding, will eventually permit items such as bathtubs and refrigerator door panels to be made of polyethylene.

## *New Steel for High Temperature Flight*

➤ AIRPLANES AND MISSILES will be able to travel up to 2,700 miles per hour without suffering heat and friction damage to structural materials thanks to a new steel.

Major structural problems of flight at four times the speed of sound can be overcome by the use of a new lightweight, ultra-high strength stainless steel developed by Armco Steel Corporation, Middletown, Ohio. The inexpensive steel PH 15-7 Mo, can withstand air friction heat of 1,000 degrees Fahrenheit, Armco president R. L. Gray said. The experimental X-2 rocket plane holds the record of withstanding 700 degrees Fahrenheit at 2260 miles per hour.

In addition to high strength at supersonic speed and a production cost one-tenth that of high-strength titanium alloys, Armco claims other outstanding qualities for its new steel, including ease of fabrication, corrosion-resistance, and assured production in volume.

The PH 15-7 Mo identification of the steel means that it is a precipitation hardened steel containing 15% chromium, seven per cent nickel and a small amount of molybdenum.

A special type of ground glass has been developed to furnish potassium to plants slowly and for prolonged periods.

A silicone coating applied to laboratory glassware dries as a clear hard skin that is resistant to acids and organic solvents.

**Division of History of Chemistry**

# Accidental Discoveries Not "Serendipic"

➤ AN AROUSED chemical engineer has gone after the lexicographers with his slide-rule, belaboring them for "grossly embellishing" and hence distorting the true meaning of a word often used in describing scientific research.

The word that set it off was "serendipity" — which has enjoyed high favor of late among writers and orators trying to explain the unplanned or accidental nature of some important scientific discoveries.

The custom is to label such discoveries as examples of "serendipity," and to imply that this is a sort of mystic principle of research whereby certain lucky scientists frequently stumble upon valuable findings they aren't looking for. One dictionary traces the word "serendipity" to Horace Walpole, eighteenth century English writer who is said to have coined it from the title of a Persian fairy tale, "The Three Princes of Serendip." These princes, it seems, "were always making discoveries, by accident and sagacity, of things they were not in quest of." Another dictionary says "serendipity" means "the ability of finding valuable things unexpectedly."

No such thing, said Bernard E. Schaar of Chicago. On the contrary, he said:

"Serendipity, from its erroneous conception by Walpole, to the inspired meanings invented by lexicographers, does not have a leg to stand on as a substitute for the phrase — accidental scientific discovery."

And who is Mr. Schaar to challenge the learned scholars who compile our dictionaries for us? Well, Mr. Schaar, it turns out, is not only a chemical engineer and chairman of the board of Schaar & Company — he is a man who has taken the trouble to read the whole story about the three princes. And he has learned that the modern notion of "serendipity" is based upon a "wholly erroneous characterization of their experiences." In fact, he asserted, "there is not a single incident in the whole book that can be characterized as a discovery, 'accidental or by sagacity,' or otherwise."

Mr. Schaar found a 1722 English translation of the story in the Rare Book Section of the Newberry Library in Chicago, and he believes it was this translation which Walpole read. It is Mr. Schaar's guess that Walpole, a voluminous writer and doubtless a very busy man, just skimmed through the tale and jumped to a false conclusion about the princes' discoveries.

All naval vessels and some types of commercial ships built after about 1960 probably will be nuclear powered, it is predicted.

Livestock researchers now have an easy way to determine the fatness of a hog carcass accurately by a measure of specific gravity.

# Autos Get Major Blame For Smog

➤ "LAUGHING GAS" formed in the upper atmosphere was cleared of any responsibility for production of earth-bound smog at the American Chemical Society meeting.

In reporting that upper atmosphere nitrogen compounds are not related to smog formation, as some theories have suggested, an Air Force scientist gave ammunition to a growing body of researchers who place the blame for the increasing smog and air pollution threat on automobiles. Other chemists promptly elaborated with detailed evidence against auto exhaust fumes.

Dr. Lewis E. Miller, Air Force Cambridge Research Center, Bedford, Mass., ruled out the possibility that nitrogen compounds always associted with smog might be formed at high altitudes by natural reactions. Although nitrous oxide, sometimes called "laughing gas," is found at very high altitudes, it is prevented by an atmospheric layer from reaching earth where it could engage in the formation of smog, Dr. Miller said.

Sunlight, it is thought, acts on nitrous oxide to produce nitric oxide and nitrogen dioxide, major smog ingredients. When this upper atmosphere nitrous oxide passes through the lower ozone layer girdling the earth, the laughing gas is broken down into harmless components not associated with smog, Dr. Miller believes.

The Air Force scientist emphasized that, so far as his report is concerned, the work does not rule out the possibility that nitrogen oxides are formed lower in the atmosphere, below the ozone layer. He told CHEMISTRY that before the relationship between nitrogen oxides and smog formation can be thoroughly understood "information of the chemistry of these oxides at all levels of the atmosphere is needed."

Most air pollution theories name automobiles as the major culprits and hold that smog-forming nitrogen oxides pour into the atmosphere from car exhausts. The evidence amassed against automobiles in recent years was strengthened by these reports before the ACS symposium on air pollution:

1. The amounts of nitrogen oxides released through exhausts depend on the immediate operating condition of the engine, G. J. Nebel and M. W. Jackson, General Motors Corporation research staff, Detroit, reported. The influencing factors are air-fuel ratio, spark timing, manifold pressure, engine speed and compression ratio, with greatest amounts of nitrogen oxides formed by "lean" fuel mixtures containing too much air.

2. The variables reported by the General Motors scientists were confirmed by D. A. Hirschler and R. C. Getoor, Ethyl Corporation Research Laboratories, Detroit, who verified their laboratory work by road tests with passenger cars.

3. Smog ingredient measurements made in Los Angeles by Air Pollution Foundation scientist Dr. Lewis H. Rogers showed a direct correlation between smog and the presence of automobiles. He said recent measurements made near a heavily-traveled freeway showed higher concentrations of nitrogen oxides than reported by an earlier test made away from traffic.

4. Earlier reports indicating smog formation does not depend on the type of gasoline burned were denied by Dr. Paul P. Mader, Joseph Gliksman, Marcel Eye and Dr. Leslie A. Chambers, also of the Air Pollution Foundation. Gasolines of a type produced before 1940 have less smog-producing ability than do the fuels marketed since 1942. However, they pointed out, new types of gasoline, finding increased use the past two years blended with other gasolines, contain fewer smog producing ingredients.

**Leaded Gasoline Threat**

Anti-knock gasoline additives containing lead may threaten the health of persons whose occupations keep them in heavy automobile traffic, although there is no health hazard to the majority of the population.

A study of tiny lead particles formed from the combustion of gasoline containing tetraethyl lead was reported by a University of Chicago chemist to the American Chemical Society meeting.

Persons who follow average occupations and spend only a normal amount of time in or near heavy traffic inhale only about one-third the maximum allowable concentration of lead particles, Miss Barbara J. Tufts, department of meteorology chemical analyst, reported.

With the small concentrations of lead particles in the atmosphere, no health hazard exists for most of the population, "except possibly to those whose occupations require a constant exposure to highway atmospheres," Miss Tufts said.

She added, however, that "serious consideration ought to be given the matter in view of the expected increase in automobile population in the future."

Miss Tufts reported she drew air samples through fine membrane filters that captured all lead particles, then chemically analyzed the filters for lead content. She found the greatest number of particles to be of a size that could most easily reach the lung, one to three microns. A micron is about four one-hundred-thousandths of an inch (0.00003937 inch).

She said her samples were taken under various traffic conditions, including starting and stopping, rapid and slow speeds.

Miss Tufts undertook the study, she said, for two reasons: (1) the role of the automobile in smog and air pollution problems has aroused interest leading to studies of the gaseous combustion products but not of possible lead particles products, and (2) lead by itself is a toxic agent and its effects can be cumulative.

**Find Smog Irritants**

Scientists will be able to dig deeper into the smog problem with a new technique which will permit the identification and isolation in sizeable quantities of air pollution components.

Urban atmospheres contain hun-

dreds of different compounds. So far about 100 organic compounds have been extracted in pure form, of which only a few have been positively identified. The main technique used so far, chromatography, yields smog compounds only in minute quantities.

A new technique reported by University of California scientists permits the isolation of these compounds in much larger quantities. This should permit the identification of the separate components of air samples, and also allow scientists to determine which are capable of causing cancer and whether the cancer-producers are present in large enough amounts in the air to start cancers.

The new method is called fractional sublimation. Smog samples are placed in a tube, heated and vaporized. When they resolidify they do so in pure crystalline bands at different points along the tube. The tube is cut into sections, each containing different components.

The research was performed by Jerome F. Thomas, Bernard D. Tebbens, Mitsugi Mukai and Eldon N. Sanborn.

**Simulate Fallout in Lab**

Synthetic nuclear bomb fallout made in a laboratory is being used by the Navy to determine the effects of breathing air contaminated with radioactive particles, a report before the American Chemical Society disclosed.

The study, made primarily to help plan defenses against war-time radioactive fallout, also applies to nuclear reactor accidents, radioactive waste disposal and even, to a limited extent, to everyday air pollution problems, reported Dr. William B. Lane, U. S. Naval Radiological Defense Laboratory, San Francisco.

Rather than study the effects of radiation itself on laboratory animals, which is being done by other groups, the San Francisco project seeks to determine the path of inhaled contaminated particles within animals, where particles finally lodge and, if possible, what preventive measures can be taken.

Synthetic fallouts, as sprays, are produced to simulate as nearly as possible real fallouts. They include some weak radioactive materials in small amounts to allow instruments to trace the fallout uptake and distribution within the animal, Dr. Lane said.

**Thorium Fuel "Breakthrough"**

A "breakthrough" that promises to free the United States from its currently expensive atomic power dependence on uranium was reported to the American Chemical Society meeting by Dr. Dennis D. Foley of the Battelle Memorial Institute, Columbus, Ohio.

The "breakthrough" is a process for the practical production of thorium fuel of reactor-grade purity. Seen as a way to get cheaper atomic power for peaceful purposes, Dr. Foley pointed out that presently uranium 235 is the only naturally occurring fissionable material and "the indispensable element in atomic energy development." Thorium, however, is three times more abundant than uranium in the earth's crust.

For this reason, he said, the procurement of thorium of sufficiently high purity for reactor applications has been one of the most serious problems, in atomic energy programs.

# Nature of Radioactive Fallout Described

▶ STUDIES OF individual particles making up radioactive fallout, which may open the way to reduction of fallout hazards, were described at the American Chemical Society meeting.

The knowledge of characteristics of fallout particles which has been obtained so far has proved useful in attacking several problems, C. E. Adams, a geologist of the U. S. Naval Radiological Defense Laboratory, San Francisco, Calif., said.

Among the areas in which data on fallout particles have been particularly helpful, according to Mr. Adams, are the prediction of radioactive fallout patterns from various types of bomb detonation, the decontamination of surfaces or structures subjected to fallout, and an assessment of the biological hazard created by the release of radioactivity from fallout particles.

"A knowledge of the processes governing the origin of radioactive fallout particles opens the possibility of manipulating the material conditions or environment of the bomb in such a way as to reduce the radioactive hazard," Mr. Adams said.

"With this in mind, the emphasis in future investigations is being placed upon studying in detail the condensation process of the vaporized radioactive elements."

With the advent of nuclear weapon testing it became apparent that the radioactive fallout following nuclear detonations could constitute a serious biological hazard, Mr. Adams pointed out. Systematic studies of fallout were first made on a small scale during Operation GREENHOUSE at the Eniwetok Proving Grounds in 1951 by the U. S. Naval Radiological Defense Laboratory, he recalled. These studies have been continued and expanded at most of the weapon testing series by USNRDL, and other organizations. One phase of this program was to study the physical and chemical properties and mode of origin of individual radioactive fallout particles, and it was these findings that Mr. Adams discussed.

"The origin of radioactive fallout particles lies in the interaction of two processes: the condensation of vaporized material in the fireball and the entrainment and heating of surface materials in the fireball," Mr. Adams explained. "The process of condensation alone would produce particles too small to descend in appreciable concentrations. It is only when the material vaporized in the fireball interacts with the surface materials, either by direct condensation onto the surface materials or by first condensing into discrete particles and then impacting and collecting onto the surface materials, that particles of sufficient size to fall in important concentrations are formed.

"For example, consider first the detonation of a moderate-size nuclear bomb on a steel tower. In this case the main vaporized species is iron

from the tower and bomb structures with trace amounts of radioactive fission products. It can be shown that the condensation of the iron vapor into liquid drops of iron oxide will begin at temperatures of about 2800-3000 degrees Centigrade. If condensation proceeded undisturbed the final particles would be quite small, most of them less than one micron in diameter. However, this process is interrupted by the introduction into the fireball of material swept up from the surface of the ground by atmospheric turbulence associated with the explosion.

"The surface material at Eniwetok consists of coral (calcium carbonate) which is decarbonated and melted (at 2570 degrees Centrigrade) into liquid calcium oxide drops. Onto these calcium oxide drops the vaporized material in the fireball collects and dissolves. The resulting particles are composed of a central core of inactive calcium oxide (subsequently hydrated and carbonated to calcium hydroxide and calcium carbonate) surrounded by a zone of radioactive mixed iron-calcium oxide (dicalcium ferrite). Some of the small, radioactive, iron-rich, spherical particles formed by direct condensation from the vapor state collect on the surface of unmelted coral sand grains in cooler portions of the cloud.

"A similar situation exists when fallout particles are formed from tower shots in Nevada. However, in this case the surface materials are low-melting, silicate minerals which form glassy drops upon which the iron and other inert metals and the radioactive fission products collect. The resulting particles consist of a central core of inert, colorless glass with an iron rich, radioactive, glassy outer zone.

**Lithium Uses Presented**

The lightest of metals, lithium, is a heavy contender among the raw materials that are revolutionizing present industrial products and production methods, it was reported at the 132nd national meeting of the American Chemical Society in New York.

"The importance of the unique chemical and physical properties of lithium and its compounds in the fields of lubrication, air-conditioning and ceramic technology has increased tremendously during the past decade," Dr. R. G. Verdieck, manager of Chemicals Research for the Foote Mineral Company, Berwyn, Pa., told a session of the Society's Division of Inoganic Chemistry at the New Yorker Hotel.

Not too long ago, service stations had to stock five or six different greases for lubricating automobiles. Now, he observed, a single grease based on a compound of lithium can be used on every part of the car requiring a heavy lubricant. In addition, the armed forces can use a single lithium grease in planes over the Arctic and in tanks on the desert, thus solving a tedious supply problem. Such an all-purpose grease is possible because the lithium compound neither stiffens at low temperature nor breaks down at high temperatures, Dr. Verdieck explained.

A second large use of lithium compounds at present is for the manufacture of vitreous or glassy products. The modern television tube uses a glass in which lithium replaces the

lead found in ordinary glass. This glass, in comparison with the ordinary kind, has increased density and refractive index, and better resistance to chemical attack. It has made possible lighter television tubes, and its lower and wider melting point has allowed the mass production of superior tubes.

But these two uses of lithium compounds, and their use in the air-conditioning industry and in the manufacture of ceramic bodies requiring high resistance to thermal shock, are only a start. With no problem of reserves for the future — the largest deposit of lithium ore in the world is in North Carolina — new applications of the unique and increasingly available element continue to grow.

The low weight and high heat of burning of lithium point to its application in high energy fuels and oxidizers for propulsion of rockets, missiles and aircraft, said Dr. Verdieck. The compound lithium perchlorate, for example, contains more available oxygen in its total weight than does any other compound.

In the plating of automobile bumpers, production rate already has been doubled through the use of lithium compounds in plating baths, he pointed out. And in the production of aluminum metal, it has permitted the use of lower temperatures and faster rates.

Lithium metal itself is valuable for its ability to speed up otherwise impractical chemical reactions, continued the speaker. In pulverized form, the metal has been used by the Firestone Tire and Rubber Company to make a natural-type synthetic rubber.

"At this very time, extremely encouraging results have been reported in the use of trace amounts of lithium salts in agriculture," Dr. Verdieck reported. Placed in the soil or sprinkled on crops, the lithium compounds find their way into the plant leaf and serve as a systemic fungicide. Good results have been obtained in controlling blight in celery, cotton and other crops. And in the future, even blights in trees may be controlled in this manner, he said.

## *Reduce Losses in Livestock*

➤ WIDER AND MORE efficient use of antibiotics, hormones and other drugs will prevent needless losses in livestock and poultry production.

Medicated feeds have been responsible for great improvements in production efficiency, Dr. C. K. Whitehair, visiting professor from Oklahoma A. & M. College, declared at the Fourth Annual Research Conference held at the Agricultural Research and Development Center of Chas. Pfizer & Co., Inc., Terre Haute, Ind.

New products are under investigation for growth stimulation, for combating metabolic diseases, such as ketosis in dairy cattle, and for controlling internal parasites in various animals.

The concept of a "balanced ration" will play an important part in animal production in the future.

**Divisions of Organic, Petroleum and Polymer Chemistry**

# New Products To Come From Sugar and Petroleum

➤ A UNIQUE METHOD of combining sugar with petroleum compounds to produce materials of wide industrial potentialties as detergents, petroleum additives, pharmaceuticals, plasticizers, resins and germicides was described at the American Chemical Society meeting.

The process affords a convenient and economical way to make a whole range of promising compounds from two of the most abundant and inexpensive classes of chemicals — carbohydrates, related to sugar, and hydrocarbons, derivatives of petroleum — according to its inventor, Dr. Carl B. Linn of the Universal Oil Products Company, Des Plaines, Ill. Some of the products are completely new, and others were formerly inaccessible from an economic point of view, the research chemist said.

In the laboratory experiments reported by Dr. Linn, ordinary table sugar, starch, cellulose and glucose (a simple sugar made from starch) were "hooked up" chemically with toluene, ethylbenzene, phenol and other petroleum derivatives through the use of hydrogen fluoride, "a workhorse catalyst of the petroleum and other industries." A catalyst is an agent that speeds up a chemical process without becoming changed in composition itself.

The new process was described as follows: The carbohydrate and the hydrocarbon are sealed in a stainless steel vessel which is cooled with dry ice because of the large amount of heat generated by the reaction. Hydrogen fluoride (HF) is piped in and the mixture stirred until the action is complete. The excess HF is separated out and the product purified.

"The reactivity of HF with many organic compounds is so drastic that it might well have been expected to 'chew up' the relatively delicate carbohydrates," Dr. Linn commented. He observed, however, that their structure stands up surprisingly well throughout the whole process of uniting with the hydrocarbon.

Starch and cellulose are carbohydrate "polymers," that is, their molecules are made up of long chains of glucose units, the chemist explained. Because the HF catalyst first breaks down these chains into their individual glucose links, both starch and cellulose behave similarly to glucose in the new process.

"Although several pure reaction products may be recovered from a given pair of reactants (carbohydrate and hydrocarbon), it is possible to obtain the desired product in good yield by selecting the proper operating conditions," Dr. Linn said.

Compounds with an entire range of solubilities in water and in oil-type materials can be tailor-made by selection of carbohydrates and hydro-

carbons of various molecular sizes, Dr. Linn continued, adding:

"The only method previously available for the preparation of materials of this type, that developed by Hurd and Bonner under a Corn Products Refining Company fellowship, was too complicated and expensive for commercial practicability. The new method is considered to be both economical and commercially feasible.

"Both Universal Oil Products Company and Corn Products Refining Company are making plans for the commercialization of the process and its products. Laboratory samples of two products are now available upon request. These are 1-deoxy-1, 1-di-(ortho-xylyl)-D-glucitol, made from orthoxylene and starch, and 1-deoxy-1, - di-(para-hydroxyphenyl)-D-glucitol, from phenol and starch.

The paper was presented before the Society's Division of Petroleum Chemistry.

**Nylons From Sugar**

New nylon plastics that have unusual properties and are expected to cost less than the present product will be made from sugar.

It will be possible to "tailor" the properties of the new nylons, or polyamides as chemists call them, to make everything from sheer stockings to ball bearings, Dr. Donald E. Hudgin, research group leader, and Frank Brown, head of the polymer research section, Central Research Laboratories, Celanese Corporation of America, Summit, N. J., reported.

The starting compound in the production of the new nylons is 2-methylpiperazine, prepared by reacting sugar with ammonia and hydrogen under pressure. The process for preparing the starting compound was discovered at Pennsylvania State University and announced in 1954. Since its announcement, Dr. Hudgin said, many companies in the United States and abroad have expressed interest in the new reaction because of its simplicity and low cost. A project to commercialize production is underway in England, he said.

Celanese Corporation scientists synthesized 50 different new nylons from the sugar-based compound and then developed processes for altering their physical characteristics.

By regulating the proportion of 2-methylpiperazine in the new nylons, and carefully selecting the other ingredients, nylons can be made "hard" or "soft" as required by their final uses. Strength can be increased and water sensitivity controlled, Dr. Hudgin said. The new nylons can be tailored to have melting points much higher than existing polyamide products, he added.

**Black Plastic Preservative**

A wide variety of plastic products in common use will be better and last longer as a result of new plastic preservatives.

Bell Telephone Laboratories scientists have overcome the oxidizing, or weakening, effects of carbon black in polyethylene plastics by modifying antioxidants that perform well in the clear plastic, but are not satisfying in the black product.

Polyethylenes are relatively soft plastics that have gained fame as "squeeze bottle" materials and are widely used in electrical insulation, flexible tubing and refrigerator bags. Normally polyethylenes are colorless, but small amounts of powdered car-

bon black are added when a black product is desired, or to give weather resistance.

In the presence of carbon black, ordinary antioxidant preservatives, aromatic amines or phenols, are effective for less than 200 hours in high-speed tests at 284 degrees Fahrenheit, the Bell scientists reported.

W. L. Hawkins, V. L. Lanza, B. B. Loeffler and F. H. Winslow altered these antioxidants with sulfur dichloride to produce substituted thioether preservatives which are effective for more than 2,000 hours under the same accelerated conditions.

The Bell scientists reported that the new antioxidants appear to take advantage of the carbon black in the course of preserving the plastics.

**New Anti-Arthritis Drugs Made**

The synthesis of two new drugs reported to have high anti-arthritis activity in animal tests was announced.

Similar to the natural hormone hydrocortisone in both activity and chemical structure, the new agents were produced by a process which appears to be adaptable to commercial production, according to Dr. E. J. Agnello of Chas. Pfizer & Co., Inc., Brooklyn, N. Y. Chemically, they are also similar to Sterane, another hormone-like drug presently used to treat rheumatism, arthritis, asthma and related conditions.

Known technically as delta-6-dehydro-9a-fluoroprednisone and delta-6-dehydro - 9a - fluoroprednisolone, the drugs exhibited high "glucocorticoid (cortisone-like) and anti-inflammatory activity" in the laboratory, it was reported. They are now undergoing clinical trials.

Chemists have been working for some years in an effort to obtain drugs of greater strength than those presently on the market for the treatment of inflammatory diseases. The more powerful drugs, it is hoped, may make it possible to give patients smaller doses and thus to minimize, or even do away with, the unpleasant side-effects which sometimes occur after extensive treatment, Dr. Agnello explained.

"The discovery of cortisone, hydrocortisone and ACTH in 1949 marked the first great break-through in the treatment of these inflammatory diseases," he said, adding: "The second came three years ago with the synthesis of prednisone and prednisolone, which resemble hydrocortisone, but are three to five times as potent. Pharmaceutical chemists have continued to search for even more potent agents."

The paper was presented before the Society's Division of Organic Chemistry.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## *Flint Prepares to Become Young Science Hub*

Flint, Mich., a major automobile hub, is preparing to become a young scientists' hub.

Flint will host the Ninth National Science Fair next May, when about 300 high school scientists, together with their prize-winning scientific exhibits, will descend on this Michigan city to compete for national honors.

With the same know-how used to plan a future automobile, the entire Flint community is busy planning this national event. Both the universities and most industries in the area are readying their scientific marvels to display to the youngsters from throughout the United States.

At the same time, the senior scientists here will see on display the scientific projects created by these teen-agers during the Fair, which runs from May 7 through 10.

The Fair is conducted each year by Science Service's Science Clubs of America for students who have been chosen as finalists representing their state and regional science fairs. The local committee administering the Fair for Flint is headed by Richard Harbeck and involves the entire community.

## *On the Back Cover*

➤ ROCKET NOSE CONES *returning at many times the speed of sound from high altitudes can reenter the earth's atmosphere without burning up, thanks to new materials developed by chemists. Materials used have not been disclosed, but some of the nose cones are believed to be made of a new high-strength, high-temperature glass. The picture shows the firing of a huge (four stories high) Lockheed X-17 missile used to test properties of nose cone materials. The 40-foot, three stage rocket weighs six tons and is propelled by solid fuels. During the X-17's six-minute flight into the ionosphere and back, information on friction heat, acceleration and other performance factors is continually broadcast to ground receivers.*

# Book Condensations

TESTED DEMONSTRATIONS IN GENERAL CHEMISTRY — Compiled by Hubert N. Alyea — *Division of Chemical Education, American Chemical Society,* paper, $1.50. To help and encourage high school chemistry teachers.

CHEMISTRY CREATES A NEW WORLD — Bernard Jaffe, introduction by Glenn T. Seaborg — *Crowell,* 321 p., illus., $4.50. To tell intelligent adults who never had an opportunity to take a course in chemistry about some of the more remarkable achievements of the science in recent years.

AN INTRODUCTION TO QUALITATIVE ANALYSIS — T. R. Hogness and Warren C. Johnson — *Holt,* 376 p., illus., $3.95. A condensation of the authors' text "Qualitative Analysis and Chemical Equilibrium."

A SHORT COURSE IN QUANTITATIVE ANALYSIS — Hobart H. Willard, N. Howell Furman and Egbert K. Bacon — *Van Nostrand,* 2d ed., 243 p., illus., $4.25. Presenting the subject in an introductory form that may be covered in a one-semester course.

THE CHEMISTRY OF ORGANOMETALLIC COMPOUNDS — Eugene G. Rochow, Dallas T. Hurd and Richard N. Lewis — *Wiley,* 344 p., diagrams, $8.50. A brief and readable review of the subject useful to the student and also the more general reader with, however, a background of chemistry.

ORGANIC CHEMISTRY — Louise Kelley—*McGraw-Hill,* 757 p., diagrams, $7.50. Text for a first-year course.

SYSTEMATIC ORGANIC CHEMISTRY: Theory and Applications — Hugh C. Muldoon and Martin I. Blake — *McGraw-Hill,* 828 p., illus., $7.75. A text for the general student. The senior author died after the manuscript was completed but before the actual printing.

THE CHEMICAL FORMULARY: A Collection of Valuable, Timely, Practical Commercial Formulae and Recipes for Making Thousands of Products in Many Fields of Industry, Volume X — H. Bennett, Ed.-in-Chief, 392 p., $8.00. For chemists and nonchemical executives.

INSTRUMENTAL ANALYSIS — Paul Delahay — *Macmillan,* 384 p., diagrams, $7.90. Covering the most important methods of instrumental analysis not generally discussed in courses in physics and physical chemistry. For undergraduate and graduate students.

THE INDUSTRIAL CHEMISTRY, PROPERTIES, AND APPLICATION OF SILICONES — Charles E. Reed — *American Society for Testing Materials,* 47 p., illus., paper, $1.50. Reviewing the basic structural chemistry of the silicones and discussing how this chemistry explains their properties as a group of engineering materials.

QUANTITATIVE ORGANIC ANALYSIS —James S. Fritz and George S. Hammond — *Wiley,* 303 p., diagrams, $6.50. A previous course in elementary physical chemistry is desirable but not essential to the understanding of this text.

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